AGRICULTURAL ENGINEERING

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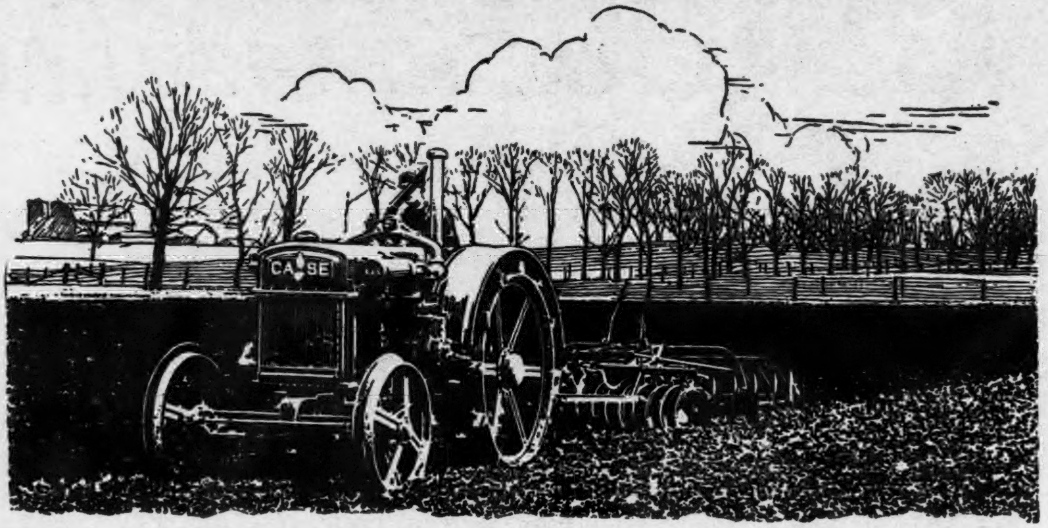
The Engineer's Point of View

ONE element of the farm building problem seems to have been considered heretofore from the wrong viewpoint. We have been so concerned with the apparent high cost of housing farm animals that our efforts at a remedy have been directed almost exclusively to a direct reduction of cost through a modification of design, regardless of consequences. This is the wrong attitude to take. . . . . What we must do is to work out the most economical means for meeting actual physical requirements, let the cost be what it must . . . . . . A detailed study of building costs in relation to dairy production, for example, shows that low producers will not return a profit, even if no building charge is made against them. Obviously the remedy should be to weed out the low producers and house the good cows in a building which will be conducive in all respects to economical and efficient production.

J. L. STRAHAN

JANUARY-1928



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Vol. 9 JANUARY, 1928 No. 1

CONTENTS

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Are Farm Buildings an Expense or an Investment?*

By J. L. Strahan[1]

AT THE 21st annual meeting of the American Society of Agricultural Engineers (June, 1927), Prof. John Swenehart, agricultural engineer of the University of Wisconsin, focused the attention of agricultural engineers on certain economic features of the farm-building problem. He emphasized the desirability of formulating a comprehensive research project which would have as its ultimate objective the reduction of overhead charges resulting from the high cost of dairy buildings as they are at present designed, by modifying the design to conform to more economical methods of layout and construction. He, frankly, did not have constructive suggestions to offer as to how this should be done other than that such suggestions should logically result from a program of research. His method of approach was openly destructive.

I would not have it thought that I am in the least antagonistic to such a method. To destroy what exists is to make imperative the construction or development of something to take its place; and I fully expect that he considered his paper as being in the nature of a preliminary step in an ultimate readjustment.

As I see it very little can be done toward solving any design problem until a clear statement of the conditions that must be fulfilled by the completed structure is available. We can't solve a problem until we state it. I believe that such a first step remains to be taken in the case of practically every one of our animal-shelter structures. Who can tell us just what are the best environmental conditions of temperature, humidity, light and air for poultry, hogs, sheep or cattle? Has anyone yet formulated the most efficient plan of management for milking cows, for beef cattle, for the different breeds of poultry? Has our farm management work as yet progressed far enough beyond the survey stage to enable specialists in this field to advise us concerning all those economic factors which affect proper arrangement of buildings in a group or of floor space units in a building? Has there been any attempt to relate official sanitary regulations to the practical requirements for economic and sanitary production of milk or milk products? Somewhere there may be answers to these questions. I have been directly interested in farm building design for a number of years, but I for one am still largely in the dark.

Very likely, in a number of cases, the difficulty lies in a lack of contact or cooperation with specialists in the several applied sciences mentioned. If that is all that hinders, the remedy is obvious and easy to apply. However, I am inclined to think a survey of the situation will disclose the fact that much research must be carried on before satisfactory standards of optimum conditions can be formulated.

Some of our designs, our so-called modern structures, fall so far short of meeting conditions as to be almost ridiculous. For instance, we have developed a "sunshine" hog house, consisting of an arched roof over a low-walled floor, housing two rows of pens separated by an alleyway lengthwise through the center. Our draftsmen and designers have gone to exquisite pains to locate windows in the roof so that the sunshine will fall on the hogs bed at a certain time of the day during certain periods of the year. This was done on the assumption that the sunshine would, first, warm the house, second, keep it dry and, third, provide for an ultra-violet bath for the little pigs. If the sunshine could be counted upon to do this everything would be lovely.

But in February and March, the usual farrowing period, direct sunshine is available on an average in most of our northern climates for only about two hours out of the twenty-four. What happens during the other twenty-two? First, heat is rapidly dissipated through the glass, this material having a very high transmission coefficient. Second, moisture condenses from the air in the house on the glass and runs or drips back in the bed. Third, even when the sun is shining, about 90 per cent of the ultra-violet rays are filtered out of the light as it passes through the glass, although this latter statement is not true of some of the more recent glass substitutes.

But in the main, instead of getting a warm, dry house

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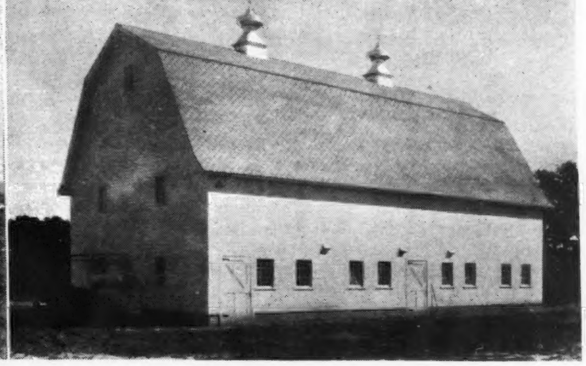
[1]Agricultural engineer and manager of ventilation department, Louden Machinery Co. Mem. A.S.A.E.

With proper management good buildings and equipment will pay their way

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what we have actually accomplished is a cold, damp one. Yet the "sunshine" hog house goes merrily on getting itself built largely through the impetus imparted by its lovely sounding name "sunshine."

The same thing has been true of dairy stables in some sections. I have seen stables built with eight and ten square feet of glass per cow when three or four are ample.

Our half and full monitor poultry houses belong in the same class of misfits, and I am not at all sure that this is not true of most of our present generally accepted poultry house designs. Undoubtedly there are many other examples of just this sort of inadequate design. It can be attributed, I think, most largely to the fact that a definite and clearly stated set of conditions or requirements for design have not been available. And they have not been available because nobody knows what they are. What we need and must have is real research, more research and then more and more research. When we really have something substantial to go on, agricultural-engineering service in the architectural field will be something more than merely a high-sounding phrase with which to impress our clients.

While we must admit that our knowledge of fundamentals concerning certain classes of buildings is very limited, yet I suspect that we have learned a few important facts concerning the housing of dairy cattle.

It is quite generally accepted among dairymen that cows produce more, everything else being equal, when kept at a temperature of from 35 to 45 deg. F. than at either a lower or higher range. At these temperatures a relative humidity of from 75 to 85 per cent is not objectionable. We can put it this way until some future test data proves other humidities to be better. No dairyman will tolerate, if he can help it, moisture condensation on walls and ceilings of his stable. Common practice has pretty definitely eliminated all plan arrangements of milking barns, except those which consist of two rows running lengthwise of the building facing either toward the center or toward the side walls.

Have we not here a quite definite set of conditions to be met in design? We must house the cows so that they will be kept at as nearly as possible a uniform temperature of 40 deg. F., and a relative humidity of 75 per cent. The stable must be dry at all times and its plan must conform in arrangement to the most efficient productive organization possible.

We can meet that program—and at a cost that will not be excessive.

Let us consider this problem somewhat in detail. The conditions to be met require that means be taken to prevent large temperature changes in the stable during periods of quite wide fluctuations outside.

Obviously, the wall of the stable must be tight to prevent rapid leakage of cold air under high wind pressure. Furthermore, it must be insulated sufficiently so that excessive heat loss through radiation will be impossible. If the wall is to be dry inside, it must be insulated well enough to prevent chilling the stable air, that comes in contact with it, to below the dew point. When air is moisture laden to the extent of 75 per cent relative humidity at 45 deg. F., it takes only 9 deg. of chilling to produce condensation. And when through a restriction of ventilation the relative humidity reaches 85 per cent, this chilling need be only through about 4 deg. The wall must be insulated sufficiently so that its inside surface will not produce this effect. It is not a difficult matter to compute exactly what transmission coefficient must govern the design to meet this condition.

It must be granted that we have not established experimentally just what are optimum stable temperatures and relative humidities. We do know, however, through observation of actual results in stables under test that a transmission coefficient of 0.20 will prevent heat loss to the extent that no freezing will occur and will at the same time maintain a dry wall surface. Furthermore, under good ventilation conditions, a temperature difference of from 40 to 50 deg. can be maintained, if there is not more than 600 to 700 cu. ft. of space per cow in the stable. I know of one instance where a temperature difference of 65 deg. was maintained in a stable whose wall had a transmission coefficient of 0.16 when only 37 cows were housed in a stable designed to hold fifty. This is scarcely possible if we are to maintain King's original standard requirement of air flow of 3500 cu. ft. per hour per cow. There is a large question, however, whether this standard is a reasonable or logical one in the light of the most recent ventilation investigations. Certainly it is seldom attained in practice. And quite as certainly natural draft ventilation systems have been designed and have functioned satisfactorily in dairy stables.

The main point I wish to make here is that the means are at hand for producing the required physical conditions in dairy stables. A proper manipulation of the factors of wall insulation, stable population, and ventilation design will do the trick. The precise reason for all the details I can't tell, but the end result, I am sure of, for the trick very certainly has been done.

The question will immediately be raised that the main issue has been sidestepped. The main issue has to do with cost. Can this solution of the problem be economically arrived at? Can such a stable as has been described be constructed at a cost that can be considered a good investment in the light of probable returns from the cows?

Before proceeding with this discussion, however, I would like to point out an element of the building problem which seems to me to have been considered heretofore from the wrong viewpoint. We have been so concerned with the apparent high cost of housing farm animals that our efforts at a remedy have been directed almost exclusively to a direct reduction of cost through a modification of design, regardless of consequences. Our slogan evidently has been "Reduce the cost at all costs."

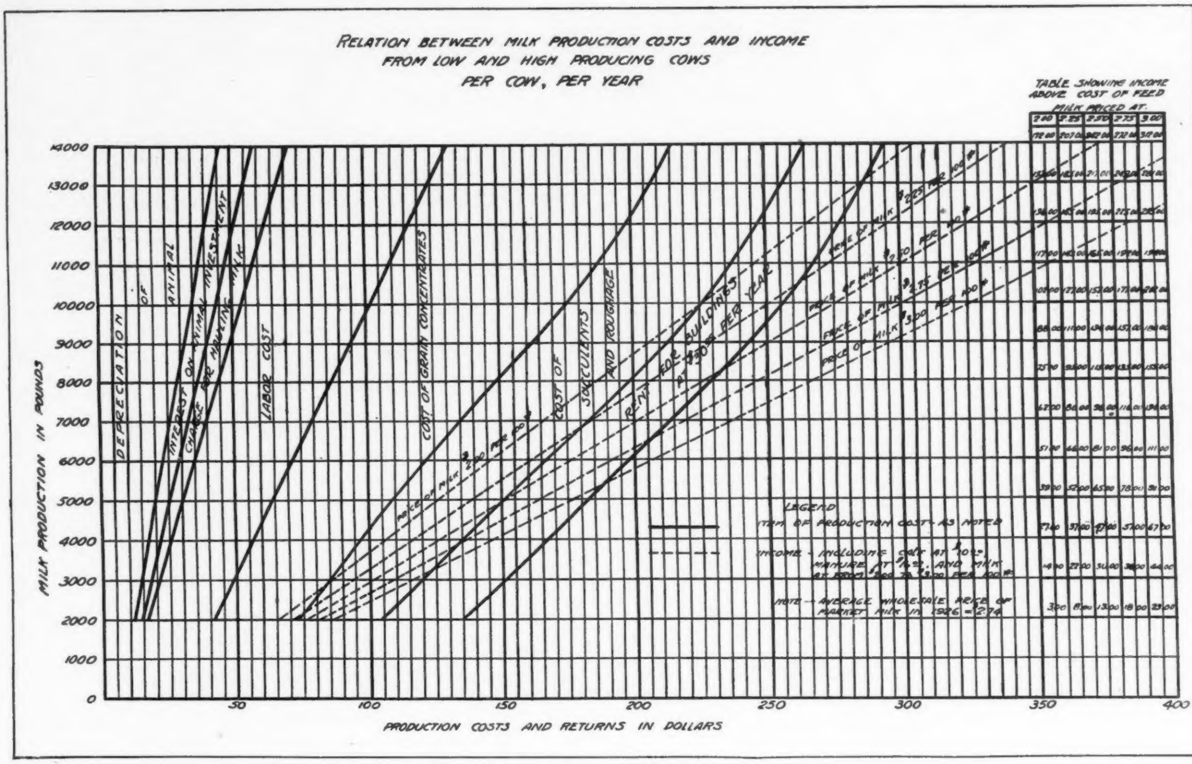
I submit that this is the wrong attitude to take. If a cost reduction is going to result in slighting some factor that has a very marked effect upon the efficiency of the building, then such a first-cost reduction is most decidedly not an economical step. A man who would save $200 on a $5,000 frame stable by leaving out insulation, will surely pay for it through rapid depreciation due to moisture condensation in the course of a very few years. It seems to me that to limit the capital investment in buildings to a certain definite amount relative to current market prices for dairy products, with the idea of getting as much as possible for this money but not to exceed it under any circumstances, is wrong. What we must do is to work out the most economical means for meeting actual physical requirements, let the cost be what it must. Most of us will agree, in principle at least, that to spend money to half do a thing is to be wasteful. This principle, if true, should certainly apply to the construction of farm buildings.

How much does the kind of a barn we would like to build cost? Let us consider a typical example.

Consider a dairy barn to house 30 milking stalls, proper alleys and enough space to care for maternity pens, calf and bull pens. Such a stable would be roughly 36 by 80 ft. outside dimensions, and would have 2880 sq. ft. of floor space. Ordinary frame construction, including concrete foundation and floor, wall insulation and ceiled finish in the stable, costs approximately $2 per sq. ft. Such a building therefore would cost in the neighborhood of $5800, exclusive of equipment. Another $1500 to $1700 should equip and ventilate this stable, making a total investment of about $7300 to $7500. This cost is at the rate of $250 for each milking cow housed. Such a barn would have all the essentials but would not be classed as fancy. It is what the building-equipment industry would consider a practical modern dairy stable. A smaller barn would cost more per cow, but a larger one will cost less. The following discussion is based on a cost of building and equipping a barn of $300 per milking cow.

The question now is, Can dairy cows under present conditions of production costs and income afford to pay rent for such a building?

The accompanying chart represents graphically the relation between production costs and income from high and low-producing cows. It was prepared from data collected mostly from state agricultural college reports and U. S. Department of Agriculture bulletins. Survey results from California, Minnesota, South Carolina, Oregon, Pennsylvania,



Delaware, Washington and Louisiana have been used. Reference has been made to numerous other bulletins and reports bearing on the problem from many different states. The data, as charted, will probably not fit precisely reports from any one of the sources as the aim has been to represent average conditions as nearly as possible. For this reason also the conditions shown will probably not meet the situation for any individual. Labor and feed costs vary, the price of cows varies, and, what is perhaps more significant than any other factor represented in the chart, management varies. The chart is, however, useful in indicating possibilities and in demonstrating one essential fact that seems to have been overlooked, namely, that the average dairy cow is not a profitable producer—and one other, that a high producer will make a very good profit at present milk prices for an efficient manager.

The chart consists of two series of lines, one series solid and more nearly vertical and the other dotted and sloping more toward the horizontal. The first series represents various items of cost in milk production, the second, income from cows at different basic milk prices.

These elements all apply to the production of market milk when wholesaled, for the surveys seem to indicate that better profits are generally to be expected from a retailing business. If wholesalers can make a profit, presumably retailers can also, though here again the factor of management will undoubtedly be the deciding one.

Considering the cost factors in detail, the first line on the left of the chart represents depreciation of the animal. This item is usually expressed in terms of herd depreciation in most survey reports, the value of all animals at the end of the year being substracted from their value at the beginning. This results in a comparatively low rate of depreciation for all years until they die and then they are 100 per cent out. From 6 to 10 per cent will be by this method the ordinary rate of depreciation, and some years an actual appreciation will occur. The fact remains, however, that the cow must eventually die at which time her value is very close to nothing. For the purpose of the present case, therefore, I have taken the average length of producing life and divided it into her average value and called the result the rate of depreciation. This puts a heavy burden on the cow but that is what we want to do now. The average producing life I am told is about 4½ years. If the cow is to pay back her value, she must do so at the rate of two-ninths of it per year, or 22.2 per cent. I have assumed a depreciation rate of 23 per cent, the balance to take care of veterinary fees and other such minor charges.

The depreciation rate must be applied to the value of the cow in order to get the data necessary to plot the first curve. I have assumed a beef value of $50 as being the worth of a cow that can produce only 2,000 lb. of milk per year. And this I feel is a very liberal allowance. Some survey figures on this point are as follows: The average value of 417 cows in California, producing an average of 6,710 lb. of milk each, was $163.80. Another group of 2912 cows, producing an average of 6614 lb. were valued on the average at $107, still another group of 2782 cows produced an average of 7180 lb. of milk and were valued at $108 each. One more group of 767 cows averaged 6793 lb. of milk and were valued at $145. I am told on good authority that a 10,000-lb. Holstein cow can be purchased in Minnesota for from $150 to $200. In Pennsylvania 171 cows, producing an average of 5,753 lb. were valued at only $71.95 each. Evidently there is a wide difference in the dairy value of milking cows. Considering all the available data, I have placed the value of a 14,000-lb. cow at $200 and considered the values of intermediate producers to be in proportion to their production between the extremes of $50 for a 2000-lb. cow to $200 for a 14,000-lb. animal. Applying the depreciation rate of 23 per cent to these values produced the data from which the first curve was plotted.

In addition to this charge, the cow owner is entitled to 6 per cent interest on his investment. Adding this amount to the depreciation cost gives the data for plotting the interest curve.

The next item is a charge for hauling milk to the creamery or milk station. This has been estimated at 10 cents per hundredweight and is an increasingly larger charge against the heavier producers.

To estimate the labor, reference is made again to survey reports and to the Iowa Agricultural Experiment Station. The latter source states the average time spent in man labor for each cow is 28 min. On this basis a cow would use 183 hr. per year which at 25 cents per hour would be $45.75 per year.

The following labor items are noted in different sections:

	Cows production average—lb.	Hours of labor per cow	At 25c per hour
Pennsylvania	5753	218	$54.50
Minnesota	6500	165	41.25
Oregon	6000	185	46.25
California	6184	162	40.50
	5618	122	30.50
	5402	107	26.75
	7180	123	30.75
		Average	$38.64

Although there is a maximum variation of over 100 per cent in the amount of labor required by cows of not very greatly varying production, it has been generally apparent that high producers require more labor than low producers, with the mean being about 160 hr. for the 7,000-lb. cow. I have estimated the value of labor at 25 cents per hour, making the cost of this item for a 7000-lb. cow $40. Reducing this charge below the mean and increasing it above, I have estimated the labor charge against the 2000-lb. animal to be $25 and that against the 14,000-lb. cow at $65.

The next large item is that for feed. Because high-producing cows utilize their feed to better advantage than do the low producers, the curve for this item it not a straight line. From data secured on 7654 cows in Iowa cow testing associations, the cost of feed for cows varying in production from 2,500 to 12,500 lb. ranged from $35.67 to $83.71. Reducing these figures to feed cost per 100 lb. of milk, the figures are as follows:

Production per year—lb.	Feed cost per 100 lb. milk
2500	$1.42
3750	1.04
5000	0.90
6250	0.81
7500	0.79
8750	0.76
10000	0.73
11250	0.71
12500	0.69

In order to get equivalent values for production in increments of 1,000 lb., I plotted the above figures, production against cost, and from the curve thus derived took off the values required. They are as follows:

Cow's production per year—lb.	Feed cost per 100 lb.
2000	$1.58
3000	1.23
4000	1.02
5000	0.90
6000	0.83
7000	0.80
8000	0.78
9000	0.76
10000	0.74
11000	0.72
12000	0.68
13000	0.64
14000	0.58

By multiplying the unit cost by the production per year I derived annual feed costs for cows in increments of production of 1,000 lb. These values are as follows:

Production per year—lb.	Annual feed cost
2000	$31.60
3000	36.90
4000	40.80
5000	45.00
6000	49.80
7000	56.00
8000	62.40
9000	68.40
10000	74.00
11000	79.20
12000	81.50
13000	83.30
14000	84.00

This data was plotted on the chart and gave the curved line marked grain cost.

U. S. Department of Agriculture figures (Bulletin No. 1069) indicate that for cows producing between 15,000 and 20,000 lb. of milk per year the average annual cost of grain is $76.80, ranging between the limits of $60 and $120. These figures are somewhat more favorable than the Iowa figures, but again the less favorable ones have been used.

If we could stop at this point, everything would be fine. But the cows must have succulents and roughage, and these feeds cost money. The cost of roughage for low-producing cows according to U.S.D.A. Bulletin 1069 ranges between $30 and $35. The cost gradually increases up to about 10,000 lb., and beyond this it remains constant at around $50. From this volume of production upward the proportion of concentrates to roughage increases, the cost of roughage being increased practically none. The estimate for this item is placed at $50 for the high producers and about $35 for the low ones.

The horizontal distance from the left-hand side of the chart to this last line for roughage represents, then, what cost of production might be expected of the cow producing on the level on which the measurement is taken. It would represent the total cost, less cost of buildings. I have purposely left this item until the last in order to emphasize its relative importance as a cost item in production and to facilitate the discussion of its bearing on other items. Before bringing up this matter, however, I will first mention the second series of lines that represents income.

We ordinarily think of a cow producing nothing but milk. Milk, however, is only a by-product of the much more important biological function of reproduction; important that is from the cow's standpoint, and from nature's. The cow drops a calf every year if she has no misfortune. This calf has a definite market value either as pure-bred breeding stock, or veal or as replacement in the herd. The value has been variously estimated at from $5 to $100 depending on breed, blood, market conditions and various other factors. For the purposes of the present case we have allowed the cow a modest credit of $10 per year for her calf, little enough considering all her trouble. We have made no distinction between a calf from a low producer and one from a high producer, although no good dairyman would sell the heifer calf of a 13,000-lb. cow for as little as he would accept for the male offspring of a scrub.

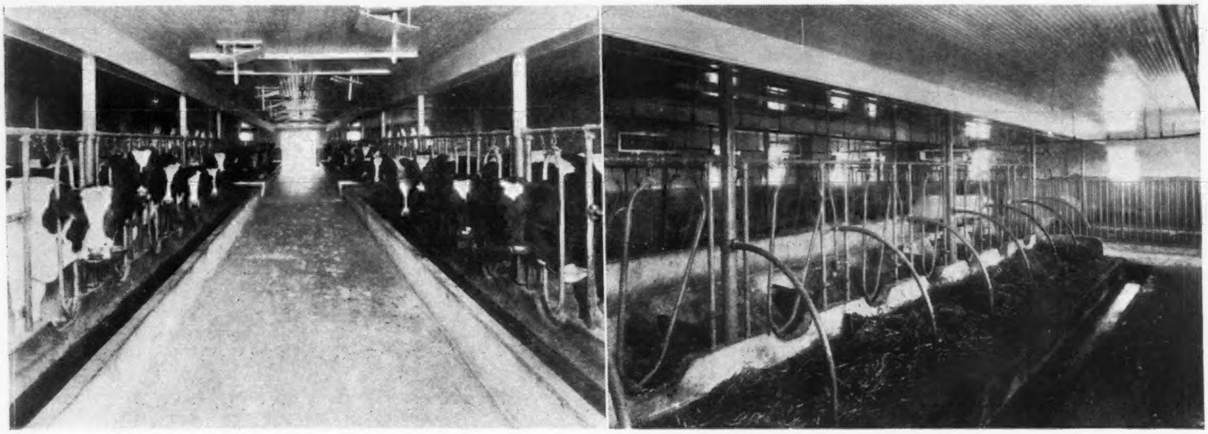
Another item which should be credited to the cow is the value of the manure. The California Agricultural Experiment Station computes the plant food value of manure to be $2.80 per ton, charging 20 cents per pound for nitrogen, 5 cents for phosphorous and 4 cents for potash. In this instance I have estimated the cow to void a total of 10 tons per year, although U.S.D.A. Bulletin No. 955 states that a 1000-lb. cow will produce 13 tons per year. I have estimated that 2 tons are wasted in getting it to the field. The balance, 8 tons, I have credited to her at the reduced rate of $2 per ton making a total credit of $16 for manure.

The manure and calf credits added together would therefore equal $26, and I have applied this without discrimination because of volume of milk production.

Refer to the first (uppermost) dotted line. It represents the income from cows considering all sources, assuming market milk to be wholesaling at $2 per 100 lb. The 2,000-lb. cow yields $26 from calf and manure plus 20 x $2, or $40 from milk, or a total of $66. The 14,000-lb. cow yields $26 from calf and manure plus 140 x $2, or $280 from milk, or a total of $306. Income from other animals range in proportion to their production between these two extremes. The other dotted lines are plotted in the same way, except that income is based on the price of milk being $2.25, $2.50, $2.75 and $3.00 per 100 lb. I might add that the average wholesale price for milk for 1926 over the entire country was $2.74 for 3½ per cent milk.

I think in building this chart I have estimated cost items liberally and have been rather parsimonious in allowing credits. I want to present the case in an unfavorable rather than a favorable light, in order to avoid the criticism that would otherwise be quite justifiable that I am trying to manufacture a case to suit a prejudice.

At an earlier point in this paper I estimated that we



The means are at hand for producing the required physical conditions in dairy stables

could build a good dairy stable, equip it and ventilate it for $250 per cow. If we could be sure of a 10 per cent return to take care of repairs, taxes and interest, it would be a fair estimate, and quite in line with industrial rentals as a whole. This rate would provide for upkeep and taxes, and return 6 per cent interest on the original investment at the same time. Estimating a capital investment of $300 per cow, the cow would be called upon to pay a rent of $30 a year each. I have plotted this item as the last cost element and called it "Rent for Buildings."

In considering this item I would like to point out one interesting characteristic, namely, its size relative to other cost elements, particularly among the higher producers. In the case of the 14,000-lb. cow it represents only slightly more than 10 per cent of the total cost of production. In the case of even the lowest producer it represents only about 23 per cent. We must admit this to be too great, but in the middle class, for cows producing between 5,000 and 7,000 lb., it represents only 15 per cent. This is not too high. This same item in industrial lines will run from 5 to 20 per cent of production costs.

There is one quite significant fact about this chart that should be emphasized. All of the cost items, except that for buildings, were estimated from actual survey figures and represent, to probably as great a degree of accuracy as it is possible to obtain from data at present available, what average cost conditions really are for this type of milk-producing plant throughout the country. The building cost item, on the other hand, by no means represents the average, but something considerably better than the average, something that we would very much like to see but which as yet does not obtain except comparatively rarely. Building cost figures from the same surveys which yielded the figures on labor and feed are about as follows:

Building charge	4.2 per cent
Corral charge	1.4 per cent
Equipment charge	2.2 per cent
	7.8 per cent

This is only about one-half the charge against buildings on the chart and must indicate that buildings and equipment already in use are not as convenient nor as well equipped as they might well be and still stay within reasonable economic bounds.

Who, then, can tell just what general effect $300 per cow judiciously spent on design and equipment would actually have on the two second largest items of production cost, namely ,depreciation on the animal and labor. Is it not reasonable to suppose that a thoroughly sanitary, properly ventilated barn will provide an environment that will be conducive to more than 4½ years of productive life? If this value should be increased to six years, the depreciation item would be reduced from 23 to 17, a saving of 5 per cent on the value of the animal, an amount equal to $10 per year for the 14,000-lb. cow added to profits; an amount equal to about $6 per year for the medium good producer of 7000 lb. This represents from one-fifth to one-third of the rental charge, a not inconsiderable item.

Is it not, further, reasonable to suppose that arrangement carefully thought out with respect to efficiency in the use of labor, and the introduction of cattle-handling equipment making for ease in doing the work, will result in a reduction of the labor charge, perhaps even larger than the saving in depreciation? To quote from Technical Bulletin 44 from the Minnesota Station, "A Study of Dairy Farm Organization in Southeastern Minnesota"; "The average man labor expenditure on Farm 21 was 182 hr. per cow for the four years before the milking machine was purchased, and 153 hr. in 1924, when a machine was used. The average labor expenditure per cow on Farm 18 was 142 hr. before and 130 hr. after the purchase of a milking machine. In both cases the cows were fed more heavily after the machine was used and their production was materially increased. This indicates that a saving in labor resulted from the use of the machine rather than from less intensive methods of care of feeding." It further indicates that the use of such labor-saving devices tends to reduce labor cost directly and at the same time to affect production and hence income favorably, both effects contributing to a larger net profit.

Is it not also reasonable to suppose that the use of such equipment as manager divisions and water bowls will result in a more efficient utilization of feed, and hence tend toward increased production? Water bowls have been demonstrated to have paid for themselves in a comparatively short period of time through increased production.

What I should like to see is a chart, similar to this one, worked out to show the effect of a $30 rental charge on the larger cost items of depreciation, labor and feed. I am quite firmly of the opinion that proper building and equipment organization will affect them very favorably; that improper or inadequate equipment and buildings will have the reverse effect, that is, skimping on this item will result in such proportionately higher charges on the other major cost items as to more than balance any direct saving. I am convinced that with proper management good buildings and equipment will pay their way.

I will refer again to Prof. Swenehart's paper mentioned in the first paragraph of this paper. In commenting upon excessive building costs he estimates as his first example that a building to house 20 cows was to cost $300 per cow. This checks with our experience and I think is a reasonable estimate. But I think he clouds the issue somewhat when he asks whether a $30 animal rental charge against the cows is warranted in the light of a probable total income return of $120. Certainly 25 per cent is too great a proportion to allow for fixed overhead. But a glance at the present chart shows that this is true only in the case of the justly celebrated "average cow." The good producers reduce this percentage to well below 15 per cent, and show a profit.

Are we to make the same mistake with our dairy cows as

we are making with our human material? We spend millions in taxes to keep our unfit humans alive in feeble-minded institutions, hospitals, sanitariums while our ablest individuals are left to shift for themselves in a none-too-gentle environment. Shall we likewise reduce our building design specifications to the point where the 4,000-lb cow will show a profit? Even if this were possible, which a glance at the chart will show it isn't, would it get us anywhere in the long run? While I do not advocate wholesale slaughter of unfit humans as a means for bettering the race, yet I do maintain that we can afford to build only slaughter houses for 4,000-lb. cows. And any man who knowingly harbors such an animal in his herd deserves exactly the losses she sustains for him.

Quite to the contrary we must build such a barn as will enable the good cow to produce efficiently, a barn in which her depreciation, labor and feed costs can be minimized—and in such a barn her probable income return will be nearer $300 than $120.

To sum up this whole problem, our first requirement is for research along lines which will enable us to state definite design conditions for farm buildings. I think we are already well enough educated to manipulate materials and physical conditions to meet them.

We need next a thorough investigation of the economics of production in dairy, poultry and animal husbandry. These are undoubtedly available but should be interpreted for the engineer's use. We should be able to show what proportion of production is represented by building overhead, including buildings that really meet the needs—in hog raising and poultry raising. A chart for hogs and poultry similar to the present one for dairy cattle would be suggestive.

So far as dairy stables are concerned, we should face the fact that poor cows do not pay under any conditions and that good ones require adequate buildings in order to put the brake on other larger and more important cost items to the end that these good cows can produce efficiently and profitably.

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AUTHOR'S NOTE: Grateful acknowledgement of many helpful suggestions is hereby tendered Prof. Earl Weaver of the Iowa State College.

"An Agricultural Revolution"

MACHINERY is working a revolution in agriculture. Industry was made over by machines. The mass production of today in the factories is possible only because of this tremendous mechanical development. The same thing, it seems, is happening on the farms. The man power needed to produce a bushel of grain or a hundredweight of meat is being reduced. Machines are taking the place of many men. Unit production an hour for labor is going up. Farmers have more opportunity than ever before to diversify their efforts and add safety to their operations.

For years the job of harvesting the cotton crop in the South has been one of hand work. It was relatively slow and costly. Manufacturing companies have sought to develop machines to do this work. During the last few years of relatively low cotton prices, growers in many sections have been harvesting cotton with sleds. This method is quick and cheap, but the cotton has to be cleaned and does not bring as good a price as hand-picked cotton. Now a great manufacturing company announces that it has built three cotton-harvesting machines. One is a cotton picker designed for the old South. It is being tested and is reported as working sucessfully. Another machine is the cotton stripper. It is a refinement of the cotton-sled idea and strips the cotton from the stalks. Stripped cotton must be cleaned. A machine for that purpose has been built. Undoubtedly these machines mean much to the South. They should cut the cost of producing the cotton crop materially.

Throughout the Corn Belt the mechanical corn pickers are cutting the cost of harvesting, speeding up the operation, and greatly reducing the labor required.

The combines seem to have taken the winter wheat belt by storm. They cut and thresh the grain in one operation and scatter the straw on the soil. They not only speed up the operation but experience has shown that they greatly reduce the cost of harvest. That means lower production costs and gives the American farmer a better chance of competing with his surplus in the world's markets.

In the hay fields of the Middle West hay loaders and stackers have eliminated a tremendous amount of hard hand work. On many farms a pitchfork touches the hay only when it is being spread around on the hayrack as it pours up through the loader. It is put into the stack or mow with a mechanical stacker or a power hay fork.

Hay now is being successfully cured by mechanical means. Currents of air are forced through the stack from a trench beneath and the hay is dried in record time, after being stacked green. Shattering of leaves is avoided, danger of damage from rain is prevented and time is saved.

The development of the tractor to its high state of perfection today has brought the farmers a tremendous reservoir of new power.

Twenty years ago truck farmers around Cleveland, Ohio, used to come into the city with their loaded wagons, drawn by horses, from one to four o'clock at night in order to be there for the market opening. They missed most of a night's rest and it interfered with their field work the next day. Now growers load their trucks late in the day, sleep until near morning and speed into town with their produce by the time the market opens. They are back at home early in the day and get in most of a day's work. Trucks put thousands of extra dollars in their pockets every week.

Every farmer ought to study this mechanical age in which he lives. He should acquaint himself with all available implements and figure out whether he can utilize them in his business. If he can do so profitably he will be in a better condition to compete with others in the production of crops and livestock. If he ignores these mechanical aids, he puts himself at a disadvantage; he maintains his costs at a high rate; he has less opportunity to diversify his efforts, and so enjoys a less secure position. Machinery is causing a revolution in agriculture. Just what the results will be or how soon they will come cannot be stated, but very definite changes are inevitable. Machines cannot be ignored; they must be used.

EDITOR'S NOTE: The foregoing is an editorial from the November 1927 issue of "Capper's Farmer." It is produced here not for the purpose of acquainting agricultural engineers with the machinery evolution that is going on in agriculture, with which they are already familiar. It is reprinted as an indication that agricultural thought in general is tending strongly in this direction. We doubt if there is a farm paper in existence that would have dared publish an editorial of tihs kind as recently as five years ago. Certainly the idea of an industrialized or engineered agriculture is taking root rapidly and in all directions.

Nationwide Combine Reports Feature Meeting

WHEN the Power and Machinery Division of the Society opened its meeting, November 29 and 30, at the Hotel Sherman, Chicago, with a symposium of reports by state, federal and Canadian agricultural engineers on combine investigations in 1927 it speedily became apparent that the combine has made substantial progress during the year. A year ago the attitude was frankly that of experiment, though the sum total of testimony was to the effect that it seemed to be an unusually successful experiment.

This year the combine seems to be accepted generally as a practical and highly desirable method of harvesting in almost all regions, and attention was concentrated on improvement and refinement, both in the construction of the machine itself and in accessory operations such as grain drying and straw saving. Attention also was given to certain special and minor crops such as rice and buckwheat.

D. C. Heitshu, agricultural engineer, Virginia Polytechnic Institute, reported observations of four combines in that state, all being new this year, and one of them being under control of the experiment station. The composite result from these machines is that all of the small grains (excepting barley, which was not tried) were handled satisfactorily. It appeared that rainfall during the combine season and moisture in the threshed grain are the limiting factors under Virginia conditions. During this season the rainfall was above average in all the areas where combines were operated, and in one instance grain to be combined was subjected to a rainfall of almost three inches in less than three hours. Almost without exception the threshed grain was so high in moisture that special precautions of one sort or another had to be employed to prevent spoiling. On the other hand, soybeans harvested in the fall seemed to store without any trouble, and this was true of beans which were stored clean, in spite of the belief of old soybean growers that beans must be left in the trash if they are to keep without heating.

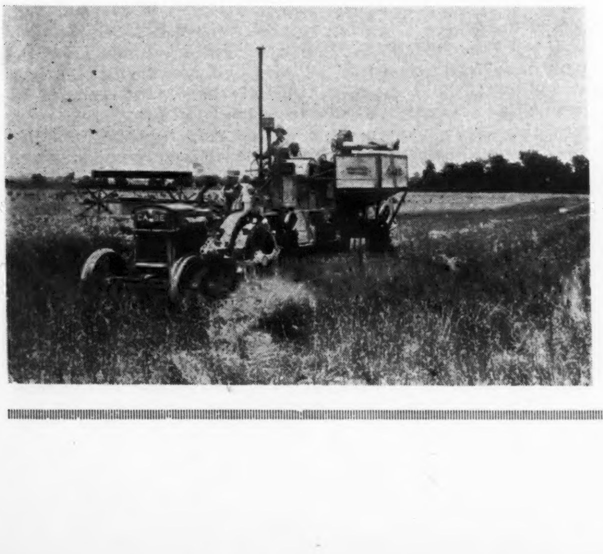
In Mr. Heitshu's opinion combines at present available are adapted to the older combine regions but are basically unbalanced for Eastern use. He estimates that with present design as a basis, the relative capacities of the various parts should be adjusted as follows: Cylinder, 100 per cent; cutter bar, 75 per cent; separator, 125-150 per cent. He adds that a machine so designed could be adapted to conditions elsewhere by cutter bar extensions of proper sizes. The "Virginia" variety of soybeans seems to call for a cylinder speed of 2300 ft. per min. for best results, with 2500 ft. per min. as the maximum. Rolling ground, the special requirements of soybeans, and other considerations make the hinged header far superior to the rigid header type of combine. Complete enclosure of the feeder housing and increased ground clearance are among the other modifications that seem desirable.

R. U. Blasingame, agricultural engineer, Pennsylvania State College, reported an increase of machines in the state from four or five to nearly thirty during the year. One previous owner had purchased two more. Detailed observation indicated that very good results, almost perfect in some cases, were being secured by the more competent operators, while some trouble and loss of grain was experienced by the beginner. Weather is a factor in Pennsylvania, but this year, at least, it seemed to be in favor of the combine, as it enabled grain to be saved in good shape in advance of rains which played havoc with grain in the shock. Reports and samples of buckwheat harvested satisfactorily with the combine were received, but details of procedure were not available. Rolling, in fact rather hilly, ground and large yields with heavy growth of straw which farmers desire to save are two outstanding conditions which combine design should be modified to meet.

H. W. Riley, agricultural engineer, New York State College of Agriculture at Cornell University, reported on experiments conducted at Ithaca with two combines of the tooth and bar cylinder types, respectively. In order to secure grain for experiments in grain drying the machines were purposely started too soon for proper combine operation, and the difficulties encountered emphasized the established advice to wait until the grain is fully ready before starting the combine. Buckwheat, when ready for cutting with binders, had soft mushy stems which broke down into a pasty mass all through the machine and led to the conclusion that the combine is not suited to handling buckwheat. Rolling, and in places rough, ground required drawbar horsepower ranging from four or five to fourteen or fifteen.

Results of these experiments and a knowledge of eastern conditions led him to conclude that where grain is to be headed and where the economic and administrative conditions are suitable, small combines as now made can be of decided service, but that where grain is to be cut low the grain platform must be wider, the reel must be adjustable, perhaps by the tractor operator, the combine should have its own engine of ample power, as tractors available have enough to do without sparing any power for a power take-off, and the separator should have more capacity in order to handle all the straw from a full width of swath, which often means heavy-yielding, long-strawed grain. He believes that a width of cut of ten feet is a maximum for eastern conditions and that the width of the machine when folded for transport must not exceed fourteen feet.

From the report of E. C. Sauve, agricultural engineer, Michigan State College, (presented by O. E. Robey) it appears that this is the first year that the combine has been studied in Michigan, and the author located and visited owners of seven machines in the southern and eastern parts of



Use of Combine Spreading Rapidly

During the year 1927 the "combine" seems to have been accepted generally as a practical and highly desirable method of harvesting in almost all regions of the country, and attention was concentrated on improvement and refinement, both in the construction of the machine itself and in accessory operations such as grain drying and straw saving. Attention also was given to certain special and minor crops such as rice and buckwheat.

the lower peninsula, and there were a few other machines which were not so studied. As compared with normal the season was extremely dry, and no trouble whatever was encountered from delays arising from weather, nor from moisture in the threshed grain, which ran from 11 to 14 per cent. The land involved was level or nearly so. Obviously the conditions were favorable and so were the observations and reports of owners. With most of the owners the straw crop is of no importance, but where it is desired to save all the straw the machine is unable to handle the volume. Unevenness in ripening was not a factor except in the case of sweet clover. Grain was allowed to stand from one to two weeks after the binder stage, and in no case was there any noticeable loss due to shattering or overripening.

I. P. Blauser, agricultural engineer, University of Illinois, reported that combines in that state increased during the year from sixty-four to more than three hundred. Following two years of experiments by the department of farm mechanics alone, this, the third, year's work was done in cooperation with the U. S. Department of Agriculture and the university departments of farm management and agronomy. Efficiency tests were made by catching straw in a canvas at the same time that grain was caught in a bag, and also by picking up all the grain left behind the cutter bar in measured areas. Losses were much higher this year than in preceding years, due apparently to weather conditions which produced unusual amounts of weeds and straw-broken grain. As might be expected, the bulk of the increased loss was found back of the cutter bar. The average total loss in wheat was slightly less than ten per cent, 7.63 per cent being back of the cutter bar.

In soybeans, as in the previous years, the combine made a very good showing, though the average loss was somewhat higher than previously. The average total loss from twelve combines was 11.38 per cent, and as in the case of wheat the big loss was back of the cutter bars because of low pods, thin stand, low branches, down beans and uneven ground. In some cases the pods were only an inch or two above the ground and often touched the ground. The loss back of the cutter bar averaged 9.85 per cent, leaving less than 2 per cent for losses elsewhere. Commenting on this feature of the report E. W. Lehmann, also of Illinois, indicated that progress was being made by planting more thickly, so that the stalks are induced to grow higher and the lower pods abort.

As in previous years studies of the moisture content of combined grain showed this figure to be lower on the average than that of grain from ordinary threshers, and indicating that this matter called for no special attention in Illinois. To get information on the matter of shattering a number of plots of different varieties of wheat were left on the university farm until October, and the result showed that shattering was practically nil until long after the usual harvesting season. Farmers should take more care to avoid weeds, and perhaps discontinue the practice of sowing sweet clover, which often grows as high as the wheat and constitutes practically a weed problem. Change in wheat varieties offers improvement.

Suggestions to manufacturers, based on observation and requests from combine users include: Increased separating capacity; less width of cutter bar; adjustable reel; closed feeder housing; easier sieve adjustment; shoes on the cutter bar to permit floating operation; more efficient divider; platform design to cut lower.

In opening his paper with the remark that this was the year marking the entry of the combine into Minnesota, A. J. Schwantes, agricultural engineer, University of Minnesota, made mention that a complete combine was built in that state in 1884 by J. L. Owens, founder of the company of that name, which still possesses part of this old machine. This machine was not put into production for precisely the reasons which have been argued against the combine in recent years.

Of the eleven combines used by Minnesota farmers this year six are of 9 and 10-ft. sizes. All employ auxiliary engines except two of the ten-foot machines which are fitted with power take-off, and one of the men owning these last intends to change to auxiliary engine, while the other is entirely satisfied with the take-off.

Experience was had with wheat, barley, oats, rye, flax and succotash, also a small field of timothy and some attempts with sweet clover. In the ordinary grains operation was so satisfactory and losses so low as to call for no comment, but in the case of flax results were contradictory, some farmers reverting to the binder and others reporting considerable losses, one estimating his loss as high as 25 per cent, while others seemed to operate satisfactorily. At the stage when flax is cut with the binder most of the bolls have ripened but the stems are still green and on the same plant there often are green bolls and even some flowers. This condition, or the presence of weeds, necessitates cutting high and leaving a considerable amount of seed in the stubble, and even this expedient does not prevent sufficient green and moist matrial getting into the machine to embarrass the separating and cleaning mechanism. The more successful operators let their flax stand until there was less moisture in the stalks, and several of their fields showed some loss from bolls that had fallen off before combining, but it is doubtful whether this loss amounted to much.

In a large part of the state the straw-saving problem is just about the same as in some of the states farther east. Elevator operators seemed reluctant to take combined grain on general principles, though most of them had no facilities for testing the grain to determine whether or not it contained objectionable amounts of moisture. It appears, however, that moisture is something of a problem in Minnesota, only about 45 per cent of samples taken showing moisture content of 14 per cent or less. The two chief causes of high moisture are green weeds and cutting too soon. One combine owner harvested most of his crop by the windrow method, using a binder with head removed to do the cutting, and a homemade pick-up attachment on his combine.

The report of R. C. Miller, agricultural engineer, North Dakota Agricultural College, was sharply curtailed to enable him to introduce as a special feature Collin T. Moneck, a young farmer operating 1800 acres near Jamestown, North Dakota. For North Dakota conditions Mr. Moneck believes that 16 ft. is the smallest practical size of combine, and 20 ft. as much as should be used in the rolling sections of the state, while in level coountries a 24-ft. machine is highly satisfactory. He believes that there is no need of a reel adjustment where the grain is merely headed, as is the case with him. He brought out the point that by the time grain stands long enough to be ripe for combining the straw is valueless for feed, being like sawdust. Where it is to be saved for bedding Mr. Moneck is inclined to favor the straw dump. He reported that whereas Ruby wheat is practically valueless for combining, due to shelling out before being ready to cut, Marquis stands almost indefinitely without loss except in the case of stalks which are actually damaged by hail, and these stalks show a kink, at which point they will go down after a rain.

Mr. Moneck emphasized very strongly the troubles which come from weeds, both in harvesting and threshing and in trying to keep the weedy grain in the bin. He urged the use of the very best cleaning equipment available. He concluded his remarks with the statement that he did not hook onto the binder the past season and never intends to hook onto one in the future.

From Wisconsin F. W. Duffee, agricultural engineer at the state university, reported the sale and use during the past season of three combines. One of them was reported as having been highly satisfactory, but the other two were returned to the manufacturer as unsatisfactory. As detailed reports were available only from the satisfactory machine and one of the unsatisfactory ones, the data is too meager for drawing of conclusions, but from the fact that a three-four plow tractor encountered difficulties pulling a 9-ft. machine with its own power plant on gravelly slopes it would seem that much lighter machines are necessary, as three-four plow tractors are not likely to become available to any extent in Wisconsin. Wisconsin is one of the states where straw saving is an important matter and moisture in the threshed grain is a serious problem, particularly on rolling land where ripening is uneven. The man who reported his combine as being highly satisfactory in every respect, in contrast to the foregoing, had a 10-ft. machine operated from power take-off, but

The "combine" is working a revolution in American farming methods unprecedented by any other machine, except possibly the tractor

his farm was quite level, eliminating the difficulties due to grade and uneven ripening, and with him the season was hot and dry.

At the university farm experiments in grain drying involved a small plot of barley which was cut when judged thoroughly ripe by members of the agronomy department, at least half being dead ripe and the remainder riper than usually cut with a binder, and threshed immediately. The ripest barley tested between 19 and 20 per cent moisture and the remainder slightly over 33 per cent. The grain with the high moisture content spoiled in spite of forced ventilation of the bin. Of course, forced ventilation of pin is not intended to meet any such condition of grain. The chief significance of these tests is in showing the difficulty of determining when grain is dry enough to combine. The matter of crinkling in barley remains unsettled.

The report by E. A. Hardy was presented by J. K. MacKenzie, assistant superintendent of the Dominion Experimental Farm, Swift Current, Saskatchewan, who also was author of a short supplement to the report. In the area embraced by the report, comprising the provinces of Alberta, Saskatchewan and Manitoba, the number of combines in use increased from 176 in 1926 to 774 in 1927, more than two-thirds of them being in Saskatchewan.

The season of 1927 was extremely unfavorable to the use of the combine, the spring having been very late and wet, June and July also wet and producing a very heavy growth of straw. There was less wind than usual, with the result that rust was rampant and caused large areas of grain to go flat late in July. Then on August 7 occurred a severe frost which caused substantial, although spotty, damage. Ripening was slow and irregular, delaying the start of harvest about a month, and there were two weeks of rain in September which complicated an already difficult situation. In consequence much of the grain was so badly down and tangled as to render cutting with a binder impracticable, leaving the combine and the power binder as the more satisfactory implements. Many combines were purchased in October and as late as November 2, but even the combine had to be operated at substantially reduced speed in the tangled grain.

Finding that the grain was too tough for proper handling until anywhere from 9:30 a.m. until noon, but that this toughness did not return until midnight or later, many operators equipped their machines with all manner of spotlights and by continuing to run until midnight or after were able to put in a goodly day of cutting under favorable conditions. Out of this fact comes a suggestion that the makers of combine engines might well make provision in their designs for mounting and driving a generator.

There were used this year forty-one "swathers," which is the term used in that territory for windrowing outfits. These included both commercial and experimental designs, as did also the pick-up attachments used on the combine for taking up the cured windrows. In general the operation of these devices was excellent, and it was found that the windrows were well supported by the stubble, permitting good curing and clean pick-up. Owing to the abnormality of the season, the sawfly, which ordinarily is the wheat grower's big problem, assumed no importance this year, but there is reason to believe that the swathing method will have particular value in meeting the sawfly problem as outlined by the same author a year ago.

Another expedient employed by the Canadian farmers was to cut the grain with a header discharging into a barge, these barges being dumped to form small stacks. Later the platform of the combine is driven against the base of the stack and the headed grain worked onto the platform canvas and through the machine with a minimum of labor.

In his report for Indiana, I. D. Mayer, agricultural engineer, Purdue University, stated that starting with five combines in the wheat harvest of 1926 the number in Indiana had grown to 65 at the time of the soybean harvest of 1927. In addition to the four common small grains there had been successful harvesting of millet, buckwheat, timothy seed, mammoth clover, little red clover, sweet clover, and, of course, soybeans.

Most of the farmers were operating combines for the first time and in practically all cases began cutting soon. In Mr. Mayer's opinion such early cutting is not justified as the danger of losses due to shattering and lodging after the binder stage has been greatly overemphasized. In wheat 9 and 10-ft. machines with crews of two and three men harvested at an average rate of 2 acres an hour, and in addition to low-operating cost, which in favorable conditions was as low as 5.7 cents per bushel, combine owners got their wheat on the market early enough to secure a better price. Moisture content of wheat ranged from 12.1 to 22.8 per cent, but most of the fields which were allowed to stand until fully matured produced wheat with less than 14 per cent moisture and most of it graded No. 1 and No. 2 soft winter wheat, comparing favorably in this respect with wheat from ordinary threshing. Blanket tests to determine threshing losses averaged substantially lower than similar tests on threshing machines, although the range of variation was wider with the combine. In addition the combine method escaped the losses incident to binding, shocking, standing in the shock, loading and hauling of the bundles, amounting to one to two bushels an acre, and there was less loss behind the cutter bar, the amount of savings increasing with the amount or degree of down grain.

Considerable difficulty was encountered due to weeds, particularly smart weed and milk weed which caused clogging at various points and made the grain damp. On the other hand, several fields were harvested which could not have been saved with a binder. In soybeans, for which the combine was originally introduced into the state, the harvesting losses averaged about 10 per cent of the total yield, as compared with losses up to 30 and 40 per cent by other methods. Sweet clover after pasturing or clipping was handled nicely, and even bushy stalks 6 to 10 ft. high were threshed and cleaned satisfactorily if pushed into the cylinder. Some difficulty with clogging inside of canvasses was encountered in grain leaning crosswise of machine travel, and also in grassy fields

or where low cutting was necessary. In some cases outfits with power take-off drive required an extra tractor to secure sufficient power.

In Iowa, according to the report of E. M. Mervine, agricultural engineer, Iowa State College, the combine has been studied for only one year, but operation of twenty-seven machines by as many owners was found to be highly satisfactory. In Iowa, oats are the most important small grain crop, and studies were undertaken to answer the question as to whether there are as many bushels of grain available for harvest after waiting until the moisture content is low enough for combine operation. Careful observations were made on test plots of various kinds and varieties of grain and the results, shown graphically, were presented on the screen. Briefly summarized, Iowa varieties of oats yielded ten per cent more at the time for combining than at the time for cutting with binders, and for a period of three weeks the yield continued to be equal to or greater than when put in the shock. It appears also that wheat will wait for the combine for a considerable period without loss, but that barley must be cut promptly when ready, within a very few days, if its yield is to equal or exceed what could be obtained with the binder. In making these observations the time for starting the combine was established by determination of moisture in the grain. Rainfall records for the past ten years indicate that on an average there are more days suitable for combine operation in Iowa than in Kansas.

As straw is a valuable crop in Iowa, an outfit for harvesting straw after the combine was developed and used experimentally, apparently with excellent satisfaction. The outfit consists of a baler pulled by a tractor and driven from the tractor power take-off. A hayloader drawn as part of the outfit picks up the straw from the ground and delivers it to the feeding platform of the baler. The outfit employs a crew of four men, one on the tractor, one feeding the baler, and two feeding the blocks and tying the bales, and they were kept as busy as the usual baling crew. However, a mechanical wire feeder for the baler would eliminate two men from the crew.

Experience with this outfit indicates that, instead of overloading the combine by running it low to get a large yield of straw, it would be better to merely head the grain and add a mower to the baling outfit.

Among the papers sent in by engineers who could not be in attendance was one by R. M. Merrill, agricultural engineer, Montana Agricultural College, who reported excellent results from a campaign which was put on in that state whereby arrangements were made to make moisture tests for farmers by various agencies, notably local elevators. The farmers bring in samples consisting of just enough heads for a satisfactory test, and when the samples test 14 per cent or less it is considered time to start combine operation.

To increase the capacity of combines in regions of light yield experiments were made with outfits in which the combine was accompanied by a header which added its cutting to that already on the combine platform, increasing the capacity 70 or 80 per cent with excellent satisfaction where cutter-bar capacity is the limiting factor. Attention also was given to windrowing, both by the Campbell method and by the special windrowing and pick-up equipment which has been put on the market commercially, and while every method has its faults all were considered practical and satisfactory. The tests included combining from the shock, both by the use of commercial shock pick-up attachments and homemade platform extensions or feed tables onto which the bundles were pitched, bands cut by hand, and the material taken to the cylinder by the regular platform canvas.

Studies of straw harvest after the combine developed some new and promising features. One method employed a conveyor which delivered the straw sidewise from the rear of the combine to a wagon, whence it was unloaded by slings or in whatever manner seemed best adapted to local conditions. This arrangement was found satisfactory and economical in operation. The statement by animal feeding men that practically all of the feed value of straw is in the chaff led to experiments with an extension carrier of such construction as to carry the long straw back and drop it on the ground while the fine stuff fell through and was deposited in piles by the regular straw dump attachment or carried to a wagon alongside by the transverse carrier previously mentioned.

C. L. Osterberger, agricultural engineer, Louisiana State University, sent in a brief report of an initial attempt to combine rice in the southwest or prairie area of the state. It seems that the two makes of machines tried operated very satisfactorily, but that the rice so harvested contains too much moisture to keep, and that such rice will not mill satisfactorily, leading directly to a problem of economical artificial drying. It is planned to try the combine on soybeans, but it is expected that beans growing 6 ft. high with stems over an inch in diameter near the base will present problems quite different from those of soybean harvest in other areas.

A brief report from M. R. Lewis, agricultural engineer, University of Idaho, indicates acceptance of the combine as the best method of handling the small grain crop and mentions studies undertaken to show the comparative cost and advantages of horses and tractors for pulling the combine. Early data indicates that costs are substantially equal by either method, but that tractor power has a substantial advantage in getting the crop taken care of before rain sets in, an advantage conceded by operators of both types of outfits.

In South Dakota, according to a contribution by J. Fletcher Goss, agricultural engineer, South Dakota State College, the number of combines has grown from one in 1920 to about 200 this year. In that state moisture in the combined grain seems to be a real problem, as the average of the samples taken ran about two per cent higher in moisture than the figure commonly accepted as safe. This is due in part to the fact that new owners almost invariably start cutting too soon, but the more serious cause is green material—weed seed, leaves and tips of Russian thistles, etc. These green materials not only impart moisture to the threshed grain but interfere with the proper separation and saving of grain. A case was cited of two neighbors using the same kind of machine in flax. One with clean fields had a loss of seven-tenths of one per cent, while the other, with very weedy flax, lost nearly 15 per cent of the yield. In the section of the country where most of the combines are owned, farming is so thoroughly on a power-farming basis that only 42 per cent of the combine owners visited had any horses at all. All of the combines were pulled by tractors.

Robert H. Black, in charge of grain cleaning investigations, U. S. Department of Agriculture, reported some of the more important findings thus far developed in a thorough study being made to determine the effect of the use of the combine on the grade and value of the grain, and to formulate suggestions and methods for using the combine which will produce grain of at least equal market value as compared to grain harvested by older methods still in common use in the spring wheat area. Two principal market value factors on which experimental data for combine wheat previously were lacking are moisture and test weight. Each pound in test weight has a market value of two to three cents, and each additional per cent of moisture decreases the price by a similar amount.

In brief, there is a close relationship between moisture and test weight, the test weight increasing as the moisture decreases, and vice versa. Moreover, these factors fluctuate sharply with changes in conditions and from hour to hour through the day. A specific case was cited in which local market value of wheat cut at 10:00 a.m. was 79 cents a bushel, 99 cents at noon and $1.12 at 6:00 p.m. From extensive data and observation the conclusion is reached that on average days cutting should not begin until about 11:00 a.m. and should cease about 15 min. before sundown. As this allows only about a 7-hour cutting day, some farmers follow the expedient of taking lunch in the field so as to operate continuously during the favorable part of the day. It is important in this connection that wheat, which has a high moisture content when threshed and subsequently is dried, gains at the same time in test weight, but the test weight so attained is not equal to that of the same grain which has been allowed to dry on the stalk before combining.

Closely similar relationships were found between moisture and test weight when grain in the bin was studied. When grain containing dockage is put in the bin, the wheat itself may be and often is entirely satisfactory as regards moisture content, and of goodly test weight. But the relatively small proportion of dockage is extremely high in moisture content,

and tests show that in a very short time the moisture transferred from the dockage to the wheat and eventually equilibrium, i.e., equal percentages of moisture in both ingredients, is reached. When subjected to drying influences the dockage loses moisture more rapidly than the wheat, so that the original relationship is reversed.

Here again it was found that the reduction of moisture in the wheat increases test weight, but that this recovery of test weight never was complete; in other words, reduction of moisture to the original figure, although improving the test weight, nevertheless does not bring it back to the original value. It is considered highly important, therefore, that wheat be freed from dockage either in the process of combining or immediately thereafter.

In this picture of moisture and test weight the specter in the background is spoilage. This is largely but not entirely a matter of moisture content. Dockage is a controlling influence not only because of the moisture it imparts to the stored grain, but also because of its interference with ventilation, either natural or artificial, which tends to dry and cool the grain. Whenever it is necessary to store grain containing more than 14 or 14½ per cent of moisture, it is imperative that the bins be ventilated, and that weed seed be removed to permit ventilation to be effective.

New Engineering Developments in Combines

BRIGHT promise for the pick-up attachment, a doubtful future for power take-off drive, light weight construction and standardization of combine sizes into two classes were among the points brought out in the symposium on recent developments in combines on the first day of the A. S. A. E. Power and Machinery Division meeting, November 29 and 30, at Chicago. The scheduled speakers were engineers of combine manufacturing companies.

Opening the discussion B. S. Harris, chief engineer, Massey-Harris Company, Ltd., remarked that the principal development of the year was the entry of additional companies into the business rather than technical changes or improvements of significance. His opinion is that the year shows substantial loss of ground for the power take-off method of driving combines. He regards the appearance of the pick-up device in commercial form as important, and something which every combine manufacturer should work on in earnest, at least to determine how much of a future this device has.

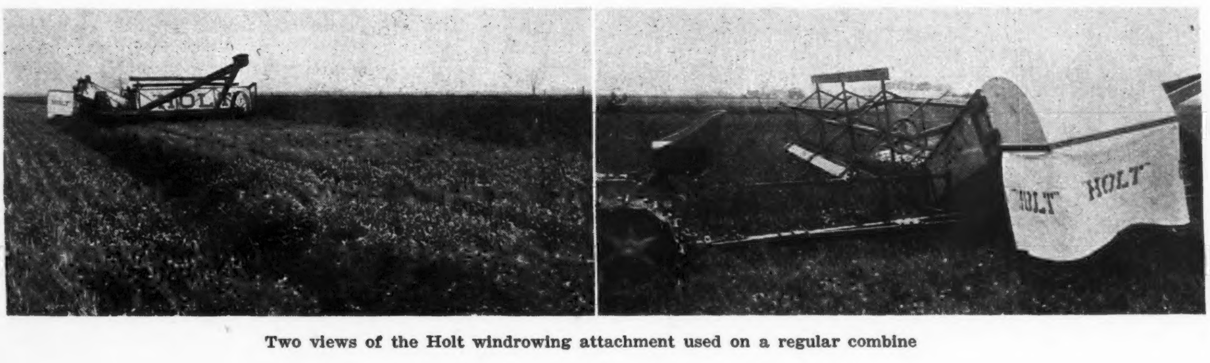
Mr. Harris enlivened the session by exhibiting a sketch, in bright colors, of the ideal combine of the future. This ideal machine is to evade all trouble from weeds and other green material, as well as eliminating the mechanical complication of the reciprocating knife and its driving mechanism, by doing its cutting with an electrically heated wire which will burn through the dry stalks but not the green material, leaving only dry stuff to enter the threshing mechanism. The difficulties now encountered in navigating combines in wet fields are to be eliminated by suspending the machine from a gas bag above instead of wheels beneath. Floating jauntily over fences and streams all transport difficulties will be solved. Propulsion is by a fan in the rear. The design embodies an atomic cylinder in which the enormous and irresistible power of the atom is invoked. Removal of threshed grain is to be by airplane. The customary conservatism of engineers was cast aside and the ideal design greeted with wild acclaim.

The discussion of W. F. MacGregor, chief engineer, J. I. Case Threshing Machine Company, noted a tendency for the combine, like all farm machinery, to assume a standard form. In his judgment the year's developments in this direction include a trend toward the auxiliary engine as the standard means of drive, the provision of grain bins and straw spreaders as standard equipment for a large part of the trade, and a tendency for each maker to concentrate on two sizes of machine. He, too, considers the windrow method to have promise.

L. A. Paradise, engineer, John Deere Harvester Works, also believes that the possibilities apparently offered by the pick-up method of operation deserve serious attention from the manufacturer. He noted an apparent tendency to settle on ten feet, or approximately that, as the standard width of cut for small combines, with the possibility of a substantially smaller machine being developed for certain territories. In the larger size class the exact width of cut is not so near being settled, and it is his opinion that this is likely to be determined by the prevailing size of tractor used in any particular territory, that is, that the combine will be as large as can be properly handled by the tractors available.

J. T. Ashton, engineer, Nichols & Shepard Company, mentioned the tendency toward standardization in major features of design with improvements in the direction of refinement of detail, and emphasized particularly the progress being made toward lighter weight, stating that machines today weigh less than half as much per foot of cut as those built fifteen years ago. Other important items of progress include the more general employment of anti-friction bearings, simplified lubrication arrangements with reduced frequency and time of application, the replacement of cast iron by drop forgings, pressed steel and malleable iron, adoption of high-grade roller chains and cut sprockets, safety clutches on important drives, higher types of gears and their enclosure in oil baths. Introduction of alloy steel and rust resisting sheet iron in place of the ordinary materials formerly employed, also greater ease in making field repairs and more attention to the convenience and safety of the operator were mentioned as important items of general progress, while specific adaptation to meet eastern conditions and the introduction of pick-up and swathing devices are important in adapting the machine to the newer territories.

John Mainland, engineer, Advance-Rumely Company, in addition to showing a film bringing out features of design and manner of operation of combines, in the design of which he has been associated, took occasion to answer the repeated suggestions emanating largely from eastern and middle western territory that the separating capacity of combines should be substantially increased to permit full-swath operation in



Two views of the Holt windrowing attachment used on a regular combine

heavy-yielding, long-strawed grain. Mr. Mainland pointed out that all farm machinery design involves compromise between extreme conditions of operation and said that a combine with sufficient separating capacity to meet the conditions stated would be excessively heavy, costly and inefficient in operation most of the time, and that all combine builders took the position that occasional extremes in amount of straw to be handled should be met by simply reducing the width of swath.

Frank P. Hanson, sales engineer, Western Harvester Company, did not go over the general ground covered by the other speakers but limited himself to describing and showing slides of the windrowing and pick-up attachments developed into commercial form during the year by his company. For windrowing the header of the combine is provided with a bullwheel which supports and drives the cutting and conveying mechanism, the material being elevated over the bullwheel and deposited in a loose, narrow windrow on the stubble. The pick-up device replaces the reel of the combine and consists of a short canvas conveyor having rather heavy slats with long steel fingers. These fingers comb the stubble and lift the windrow gently onto the moving canvas, from which it drops onto the regular platform canvas of the combine and is threshed in the usual way.

In the general discussion following the symposium, and which included a much broader field than the immediately preceding papers, Thomas D. Campbell, president, Campbell Farming Corporation, Hardin, Montana, whose illustrated talk a year ago was a feature of the meeting, stated as his opinion that all combines are too small in separating capacity, having been designed for heading only in sections where grain does not blow down or become damaged. The spread of the combine involves handling down and tangled grain which must be cut with much more straw, which overtaxes the separating capacity of combines as originally developed. Mr. Campbell, as well as Mr. Heitshu of Virginia, believes that additional width is the correct way to secure the needed capacity.

In answer to a question as to the future of the swather, Mr. Campbell stated his belief that in order to make the combine 100 per cent usable, except perhaps along the Pacific Coast, it is necessary to have available and make more or less use of some kind of windrowing device. So far as he can see the only objection to the use of windrow harvesting devices arises in areas where there are small stones in the field.

Mr. Campbell was also asked to answer a question by G. W. McCuen, of Ohio State University, as to how grain in the windrow comes through a period of very wet weather as compared with grain in the shock, including tendency to sprout. In reply Mr. Campbell stated that they had purposely left grain out under all conditions for a long time and that, even when the grain was left untouched in both cases, that in the windrow came through with less damage than that in the shock. Furthermore, a 40-ft. windrow can be turned with a side-delivery rake at a cost of 15 cents an acre. In the case of hail there is less loss in the windrow than in the shock, not because there is less grain threshed out, but because that threshed out stays in the straw and very little is lost as it is picked up by the pick-up device. Remarking that there were sixty-three rains in Montana between July 18 and October 1, aggregating nearly four inches, Mr. Campbell told of leaving fields of grain in the windrow to the very end of the season, also some adjoining fields in shock. The shocks were grown so solidly together that they could not be salvaged at all, while the grain saved from the windrows was estimated at not less than 75 per cent.

In connection with the use of the combine for harvesting unusual crops, O. W. Sjogren, University of Nebraska, cited reports emanating from Nebraska that farmers had used the combine for corn, driving the combine through the corn field and hauling away the shelled corn.

Chairman Fletcher calmed the ensuing levity by a statement that in his opinion it was only a matter of a few years until the combine constitutes the basis of harvesting operations for all crops. Hilarity increased when someone asked if combines can be used in the harvesting of watermelons. This time it was R. H. Black, U.S.D.A. division of grain cleaning investigations, who referred to his experience in raising watermelons for seed and stated in all seriousness his opinion that it might be done practically with the combine. It is not generally known that watermelons for seed are run through a threshing machine.

The matter of crop insurance rates and expiration dates being brought up, it appeared from several widely separated sources that there is no discrimination, either as regards rates or the length of time that the insurance continues in force, between the two methods of harvesting. It was pointed out that damage usually occurs before the binder stage rather than later, so that little if any additional hazard is involved, although the increasing use of the combine probably will cause the insurance companies to make an investigation and possibly revise their methods. J. K. MacKenzie, of the Dominion (Canada) Experimental Farms, mentioned cases in which Canadian farmers had been allowed 100 per cent damage—which undoubtedly was according to older methods of harvest—after which the combine was tried and an average recovery of ten bushels an acre secured.

The Status of Grain Drying Investigations

CONSTITUTING a progress report on the subject, the symposium on the latest development in grain drying at the meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, November 29 and 30, at Chicago, embraced papers from New York, Pennylvania, Illinois, and Kansas.

The contribution by H. S. Hinrichs, field engineer, Kansas Committee on the Relation of Electricity to Agriculture, dealt with the investigation of crops and conditions as they occur in Kansas. The crops contemplated are wheat and kaffir grains, although the tests were with wheat only. The conditions under which wheat may require treatment and which contribute to trouble with kaffir are grain containing considerable amounts of weed seed, pieces of weed stems or broken grain; grain with external moisture from dew or rain; and grain containing green kernels due to uneven ripening.

The experiments were conducted by the Kansas Rural Electrical Laboratory and made on one of the better managed farms of the wheat belt, using equipment with which the farmer is familiar and which is, or might properly be, already owned by the farmer for regular handling and cleaning of grain. The general procedure was based on methods commonly used by country elevators handling wheat with moisture which might cause trouble. The apparatus included a standard inside cup elevator and grain cleaner or fanning mill arranged in a remodeled granary and operated by a 3-hp. electric motor, although experience has shown that a motor of 1 hp. is adequate. The arrangement of cleaner, elevator, bin bottoms and boot was such that all handling of grain was done by gravity or by mechanical power. The cost of the complete machinery, delivered to the farm, was less than $400.

The procedure included the removal of foreign matter from the grain by means of the cleaner, and the movement of the grain for cooling and aeration as might seem necessary. During the 1927 test a sample of 15 bu. of wheat unusually foul with weed seed and weed sticks was taken directly from a combine operating under great difficulty from the weedy material and probably where no attempt would have been made to harvest by any other method. This sample was mixed with 40 bu. of somewhat cleaner but still weedy wheat, the resulting mixture containing 15 per cent moisture. Placed in a bin the mixture increased two degrees in temperature in 44 hr. in spite of surrounding air temperatures 8 to 10 deg. lower.

Thereupon the wheat was run twice over the cleaner to remove the foreign material and returned to the bin. The blast of air with a temperature of 88 deg. F. and relative humid-

ity of 52 per cent was at the rate of 442 cu. ft. per bu. The removal of foreign material reduced the moisture to 14.85 per cent. Although the difference in moisture content was slight, no further difficulty from heating or molding was encountered. Three days after treatment samples showed a further decrease of 0.3 per cent in moisture, and 18 days after cleaning a further decrease of 0.1 per cent was observed. The relatively large decrease in moisture during the three days directly after cleaning, as compared with that during the cleaning process itself or during the subsequent fifteen days, is of special interest. The entire treatment, with motor of correct size, consumes energy at the rate of 1 kw-hr. per 100 bu., and no manual labor and very little attendance is required.

In another test water was added to a 50-bu. lot of clean wheat bringing the moisture content 17.8 per cent. After standing 44 hr. the temperature increased from 84 to an average of 96.5 deg. It was run over the cleaner and through an air blast at 80 deg. and 84 per cent relative humidity. The moisture samples before and after this run were lost and the number of subsequent runs was not determined by the apparent requirements of the grain so much as for making special tests. For example, some of the grain was run over the cleaner nine times in succession, but samples analyzed showed no measurable reduction in moisture content. Although this cooling and aerating process seems not to involve any appreciable amount of drying, it apparently has some influence on the rate of natural drying afterwards, and it was observed that the handling properties of the grain improved, as shown by the capacity of the cleaner and elevator, in the proportion of 132 bu. per hr. to 195 bu. There was some reason to believe that there was a little drying action, though not disclosed by laboratory test.

Although the investigation gave negative results so far as demonstrable reduction in moisture of the grain during treatment was concerned, it is believed to point the way toward prevention of heating and spoiling, at least in wheat, at a reasonable expenditure of money, time and attention, for the two conditions of grain described.

The paper scheduled for presentation by F. la T. Budgett, New York Power and Light Corporation, was read by H. W. Riley, head of the department of rural engineering, New York State College of Agriculture. The principal equipment which might be said to constitute the basis for the experiments was cylindrical bins, 70 in. in diameter by 8 ft. high, mounted on hopper stands, together with air blowing and heating equipment, instruments, etc. False bottoms, linings and flues, presented a surface of metal fly screen to the grain with support by wooden slats, as needed.

One arrangement employed a false bottom in the bin, whereby all of the air passed through the full depth of grain; another arrangement employed a central flue of screen wire from the false bottom to within two feet of the top, and this materially reduced the average travel of air through the grain; a third arrangement employed both a central screen flue and a lining of slats and screen so that the air path was radially from the central space to the outer screen.

For drying in bags, the bags of grain were laid on their sides on the floor radially from a common center and piled three or four high, and other bags were stood up between the outer ends of those radially disposed.

Trials were begun with cold air, but this seemed to be of no value and arrangements were made to continue with air heated by steam coils. Although air temperature seemed not to be the most important factor in the results secured, it appears that nothing is to be gained by using temperatures higher than 135 deg. F., and in all probability this temperature can be used without affecting the viability of seed grain.

The length of the air path through the grain from point of entrance to exit has a substantial influence on the rate of water removal as well as the effectiveness and uniformity of drying. The best results in the bins were secured with the central flue and screen lining. As regards the rate of blowing, the effect of increased quantity of air is well marked. It seems that the best results were obtained with 830 cu. ft. per min., equivalent to 30 cu. ft. per min. per sq. ft., a figure which agrees well with the figures previously reported from Wisconsin.

Among the bins the best results were secured with heated air passing from the central flue to the screen jacket, and about the same results were secured when heated air was applied to sacked grain piled as before mentioned and with a canvas tied over the pile to confine the heated air. This method of drying in sacks is regarded as having merit when used in connection with a combine operating on the bagging system, as considerable labor is saved as compared with transfer into and out of bins.

Special tests made on smaller batches of wheat clearly confirmed the advantages of drying the grain in thin layers. It seems likely that with a screen area of 120 sq. ft. drying could be carried out at the rate of 1 bu. per min., deemed adequate for the output from a combine of moderate size.

In one of the small-batch tests grain was blown with heated air in a layer 3½ in. thick. The first 15 min. of blowing reduced the moisture from 18.6 to 18.3 per cent; after another 15 min. the moisture was down to 15.9 per cent, and at the end of the third 15-min. period the moisture was 11.5 per cent. This increased rate of moisture removal is explained by the inefficiency of air as a medium of heat transfer, it taking considerable time to warm up grain to a temperature at which moisture dissipation occurs rapidly. This leads to contemplation of the desirability of warming up the grain by some more efficient heating method, possibly by live steam, followed by blowing with hot air for drying. Obviously there would be some difficulties in avoiding overheating, but a possible advantage might be found in the surface of the grain being softened instead of being case-hardened as by dry air, permitting a more rapid transfer of moisture from the interior of the kernel to the surface.

Among the incidental observations was the conclusion that while heating always is dangerous, it is not safe to rely on temperature alone as an index of good keeping, as spoilage may occur with practically no heating.

Prof. Riley's final comment was that, although it was not done in any of these tests, where forced air draft is employed, it should be done by an exhauster fan rather than by pressure blowing.

The first part of the paper by H. B. Josephson, agricultural engineer, Pennsylvania State College, described moisture tests and weather observations involving three wheat fields, together with a survey of weather records for a period of ten years. These results cannot be reported here, other than to cite the apparent conclusion that in most years combine harvesting is not practical in that state unless means are provided to lower the moisture content of the dried grain to a figure that will insure its keeping qualities.

The grain drying experiments were of two distinct sorts, one by blowing air into the bottom of bins containing grain to a depth of several feet, after the general manner previously reported by F. W. Duffee of Wisconsin. Minor variations of this system were tried consisting of expedients for introducing and distributing the air blast in the bottom of the bin without using the screen false bottom. The other general method consisted in moving grain from bin to bin by an air blast, employing a commercial pneumatic grain handling outfit.

The blowing experiments involved two bins each of wheat and oats, the depth in both of the wheat bins being 44 in. and the oat bins 54 and 72 in., respectively. Blowing was done according to apparent need, as shown by indications of heat, and efforts were made to do this blowing when the relative humidity of the atmosphere was comparatively low. It was found that within an hour after starting the blower the temperature of the air leaving the grain was reduced to that of the room, and its relative humidity beginning at 100 per cent dropped rapidly to approximately that of the atmosphere, consequently it was considered most efficient to blow in short periods of one-half or one hour, at such times and intervals as conditions seemed to dictate. In all cases the air was unheated.

In some cases pillars of musty grain were found, due apparently to unevenness in distribution of the air blast. A decided tendency for grain in the bottom of the bin, even though moister when put in, to become drier than that higher

up was noted, and is considered an inherent defect of this system.

One of the bins of oats, 6 ft. deep, was expected on the basis of field samples to require no treatment, but after a week-end interval of two days, eleven days after filling the bin, the oats were found very hot. Ten minutes after starting the blower the air above the oats had risen from 26 to 45 deg. C., and saturated with moisture so that condensation occurred on the walls. Fearing spontaneous combustion the blower was shut down for 5 min., then started again, and the temperature rose rapidly to a peak of 55 deg. C., then tapered off gradually so that it was almost down to starting temperature at the end of the hour. Although the atmospheric relative humidity was 74 per cent, the moisture content of the samples was reduced 1.2 per cent in this single blowing, the large reduction being attributed to the increased capacity of the spontaneously heated air for holding moisture. A little more than a month later there was an unexplained increase in moisture content of 1.3 per cent occurring at a ten-day interval in which the grain was blown for three hours.

Treatment by pneumatic handling was applied to a bin filled with wheat to a depth of 52 in., and containing 18.5 per cent moisture when stored. In seven days after storing the temperature near the middle of the bin rose from 25 to 30 deg. C. and seemed to be just on the verge of becoming musty. It was then transferred to another bin with the pneumatic handler at the rate of 60 bu. an hour, being elevated by the blower a vertical distance of 20 ft., the remainder of its travel being by gravity. This grain was moved back and forth a total of twenty-three times and the moisture content reduced 3.3 per cent. The wheat so managed kept fairly well, and the amount of moisture removed in each handling was about the same as that accomplished by air blast through the grain for one hour. But as each pneumatic handling took 3½ hr., the apparent efficiency was lower than that of blowing air through the grain.

R. C. Kelleher, of the department of farm mechanics, University of Illinois, reported progress during the year in the experiments which have been in progress for several years at the Illinois agricultural experiment station in drying ear corn. Observations in preceding years having shown that unheated air at the season when the corn needs drying is unsuited for that purpose due to unfavorable weather conditions, and that heated air removed moisture rapidly from soft corn of high moisture content, an experimental heating and blowing plant, in a portable style, was built along lines similar to those at Purdue University and the Institute of Agricultural Engineering at Oxford, England.

An oil-burning furnace delivers its products of combustion, after dilution with suitable amounts of atmospheric air, to the intake of the blower, the temperature range contemplated being from 100 to 180 deg. F. The mingling of combustion products with air to constitute the hot drying blast escapes all the stack losses incident to indirect heating, and probably reduces other losses, while the presence of water vapor due to hydrogen combustion has small effect in comparison with the heat saving. Although the hot gases delivered by the blower are quite clean, a spark and grit collector is provided to avoid possibility of hot particles passing into the material being dried, this device operating on the principle of the centrifugal air cleaner.

When heating air from 65 to 145 deg. and delivering 6,000 cu. ft. per min., the fuel consumption is about 3 gal. of fuel oil per hour, and a 12 or 15-hp. motor or tractor is needed for power. It is believed that, if used in connection with cribs of proper construction and of sufficient size to utilize the full drying power of the air supply, and depending somewhat on the amount of moisture to be removed, corn can be put into good keeping condition for one to three cents a bushel.

Although designed primarily for ear corn this type of dryer is adapted to drying small grains, shelled corn, soybeans, etc., when used in connection with a continuous gravity flow drying system. It may also be found adapted to drying grain in bins.

An Overshot Soil Saving Dam

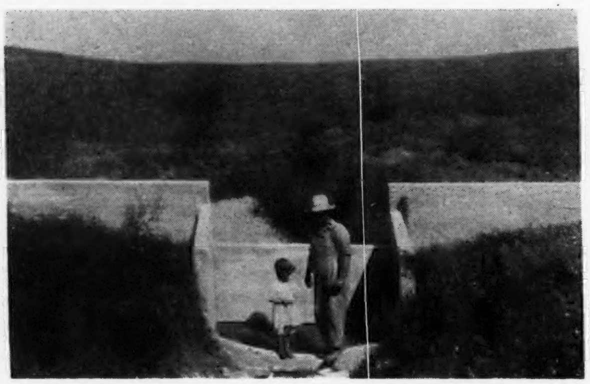
By J. C. Wooley[1]

THIS soil-saving dam was patterned after the vertical drop in the irrigation ditches used in the West. The notch is made sufficiently large to carry the water in the times of heaviest rainfall. The Missouri state highway formula for the design of culverts was used as the basis for figuring the size of notch. The wings on each side of the notch are made four feet long and an earth fill is used to complete the dam. The water cushion should be at least six inches deep to be effective in overcoming the velocity of the water. The wings on each side of the tank brace the retaining wall and the water cushion prevents undermining which would result without this protection.

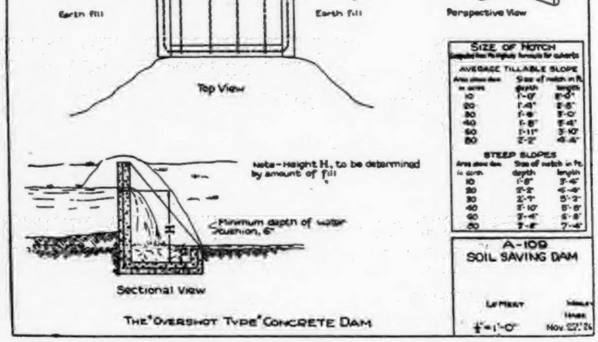
This dam is a very satisfactory installation for a fence line between fields. It then serves as a means of saving soil in the field above and makes a permanent fence construction for the ditch.

Four feet of fill has been secured in the installation shown in the accompanying picture.

[1]Professor of Agricultural Engineering, University of Missouri. Mem. A.S.A.E.



The Missouri soil-saving dam in use



Three views showing the construction of the Missouri soil-saving dam

Agricultural Engineers Consider Farm Houses at Structures Division Meeting

UNDER the chairmanship of W. G. Kaiser, agricultural engineer, Portland Cement Association, the meeting of the Structures Division of the American Society of Agricultural Engineers, on December 1 and 2, at the Hotel Sherman, Chicago, was opened by an illustrated talk by Greta Gray, professor of home economics, University of Nebraska, entitled "Planning Farm Houses for Efficient Housekeeping."

Prefacing her remarks by the observation that in the city people commonly select their homes according to location, number of rooms, and external appearance, without any very definite attention to or knowledge of what the family needs or wants, she made the point that the essential requirements of a satisfactory farm home often are just as little appreciated, and that while a good suburban type of home may do very well for some farmers, more farm homes should have something different. Later on she showed how too many farm home plans offered the public, both as plans and as ready-cut houses, are merely suburban homes, with only a little addition or alteration which can only be a makeshift, inferior both in beauty and convenience to a dwelling designed from the start for the farm and the farm family.

When the city family finds itself a misfit in its home, it moves, but this the farmer cannot do. Therefore, the farm home should be designed at the start to meet permanently the family requirements. The farm home should be planned to meet the maximum use that will be put upon it, as the family grows in number and stature. At the same time it should be so designed that part of the house can be shut off when it is not needed. It must be flexible enough to have large capacity and at the same time be operated efficiently at low load.

Miss Gray emphasized for the farm home greater provision for guests than the city home, not only because there are no convenient clubs or hotels where an overflow of guests can be taken care of, but because with the somewhat less opportunities for farm people to gain acquaintance in other ways it is important, particularly for the children, that there shall be house guests.

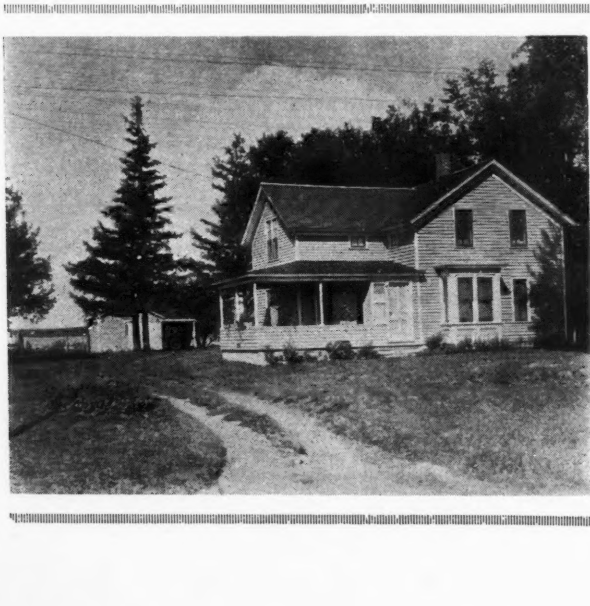
Because farm men and children come in from the soil of the field and the mud of the road instead of clean paving, and because farm duties do not terminate with a five o'clock whistle, there is likely to be more or less tracking into the house with dirty shoes and sitting about the house in work clothing. In consequence of this the farm wife likes a sort of "best room" which can be shut off from the more "every-day" part of the house, and for this reason the old-fashioned parlor, or a modern successor, has a proper place in the farm home instead of or in addition to the living room which is adequate for suburban dwellings.

With rather larger families, hired help and outdoor appetites there is more food to be prepared, and as more preparation of food for storage is practiced there is more cooking and other food work to be done than in a city home, consequently the kitchen as the chief workshop, and its connection with other parts of the house, are more important.

A truly convenient kitchen embodies much the same principles of efficiency as line production in modern industry. There are three principal work centers, namely, the stove or cooking center, the sink or cleaning center, and the work table or food preparation center. Assuming these centers to be distributed about the walls of the kitchen and that the workers are right-handed, the processes of preparing and serving meals should proceed in clockwise progression, while the operations of clearing and dishwashing after the meals are most conveniently done in counter-clockwise fashion. The end and beginning, respectively, of these operations should be as close as possible to the dining room door, and it also is highly desirable that there be no pantries, passageways, halls or other space between the kitchen door and dining room to run up the housewife's mileage in wasted time and energy.

The need of a washroom which the men can enter conveniently from the direction of the other farm buildings, without passing through any other part of the house, is freely conceded but not so frequently found. This room may or may not be combined with the home laundry, but it should either embody or be closely accessible to coat room facilities for disposing of overshoes, work garments, etc. It is preferable that the family bathroom be not used for this purpose, and it also is desirable that communication between this washroom and the dining room or other living part of the house shall not be through the kitchen, owing to the confusion caused by men passing through the kitchen to the dining room just at the peak load of serving a meal.

The suggestion was made that it would be well to work out a standard design of kitchen, rather rigid as to relative locations of openings and equipment, and insist that house plans be adjusted to this most convenient arrangement of the most important work room, rather than the apparently common expedient of designating a room for this purpose



Farm House Requirements

The farm family cannot move when it finds itself a misfit in its home. Therefore, the farm house should be designed at the start to meet permanently the family requirements. The farm home should be planned to meet the maximum use that will be put upon it, as the family grows in number and stature. At the same time it should be so designed that part of the house can be shut off when it is not needed. It must be flexible enough to have large capacity and at the same time be operated efficiently at "low load."

without regard to its layout for efficient production. In the subsequent discussion, however, it was pointed out by Prof. H. W. Riley, of Cornell University, that a single standardized kitchen plan will not work out right at all points of the compass.

Miss Gray presented on the screen a rather large number of floor plans assembled from many sources, using them to point out specifically wherein they did or did not conform to the requirements of convenience. Among them the slightly modified suburban house was clearly evident, and it was made plain how difficult it is to keep some of the desirable features from being mutually exclusive. Incidentally, she brought out how the adoption of electric refrigeration completely changed the proper location for the refrigeration. When electrically operated it should be located at the point most convenient for the housewife in preparing and serving food, whereas when ice is used it is located for the convenience of the ice man.

In the discussion several of the engineers emphasized the value which the home economics people can contribute for the guidance of the engineer and architect by determining and defining specifically the requirements of the farm home. Prof. J. C. Wooley, of the University of Missouri, told of submitting plans to home economics experts and how they subjected the plans successively to the test of Saturday night when the entire family is at home, noon on threshing day, the afternoon club, and so on.

The talk and slides by Rexford Newcomb, professor of architectural history, University of Illinois, entitled "The Evolution of American Farm Homes," combined beauty of utterance with beauty of illustration, tracing the American farm home from earliest colonial times to the present, and showing the several influences of time, climate, geography and European background.

Mr. Newcomb deplored from the architectural standpoint the same lack of adaptation which Miss Gray showed from the viewpoint of convenience and utility, mentioning for example the importation into Illinois of the Pacific coast type of house commonly known as the bungalow which "with low roof and lack of head room without adequate space, becomes very ridiculous during the hot summer months. The bedroom becomes a parboiling place up to a very late hour at night." Again, "the advocacy of the use of the Spanish type of houses in a section of our country which gets temperatures as low as 30 below zero."

With respect to the working out of standards within the house, as previously advocated, Mr. Newcomb proposed that this be done and expressed in actual structural embodiment by committees composed of architects, agricultural engineers, and home economics authorities working in cooperation, as each of these has something to contribute which the others are not qualified to supply. He explained that the architectural profession has largely neglected the farm home, and in fact all residential work of similar size, because it is more work and harder work to develop residences of six to ten rooms than a school of as many units, and the financial reward for the work is far less than for hospitals, churches, etc.

Mr. Newcomb proposed, however, that architects should do at least a small amount of work on farm homes and other small houses without regard to compensation as a sort of contribution to public welfare, commending in this connection the work of the Architect's Small House Service Bureau, of the American Institute of Architects, and adding that much more should be done in that direction.

The very first houses of the New England colonists were not log houses as usually understood, but palisade structures made by setting logs vertically on or into the ground, the palisade wall construction often being continued to form a garden wall. The principal idea of architectural construction brought along by the colonists came from rural English buildings of the half-timber type with wall filling of wattle and daub. Finding that this sort of filling between timbers did not meet the conditions imposed by New England winters they added clapboarding, which proved so effective in excluding wind and water that it became the backbone of the New England exterior and lives to this day as siding.

With the passage of time in New England, and with the climatic changes attendant upon progress southward along the Atlantic coast there was a trend away from the stern, box-like rectangular design of early colonial days, with a large central chimney. In New England this trend first manifested itself in the addition of a wing or lean-to at the middle rear of the house, constituting a kitchen utility. In the South, under the influence of the milder climate, an extensive plantation system and slave labor, the wing idea was carried much further. There were two wings, one the kitchen wing and the other an office wing, usually symmetrically arranged with respect to the main part of the house and rather sharply separated from it, the limit being reached in having these wings as separate buildings connected with the main house and by arcades, not only beautiful in layout, but in thoroughly practical relation to climatic conditions and the social system.

Following time and emigration westward it is apparent that New England ideas of home building were carried along into the Middle West. An interesting feature characteristic of this region and time is the summer kitchen, usually a one-story wing. About the middle of the last century the Middle Western architecture was marked by the introduction of Greek motifs and a vogue of French doors.

Kentucky and adjacent territory made a definite contribution to rural architecture, beginning with the log cabin of horizontal logs, the origin of this architectural style being rather uncertain but believed to have emanated from Scandinavian sources. These humble and utilitarian dwellings were built originally by the settlers for their own abode, and in them are preserved some wonderful fireplaces, but as time passed and prosperity increased the owners built more pretentious dwellings and the cabins fell to the negro help. The newer and larger plantation homes had a tendency to repeat on a larger scale the lines of the log cabin, and some of them were made of log construction covered with clapboards, just as the clapboards were added to the early New England houses. The same architectural proportions also were carried out in stone, and somewhat later in brick.

As the essence of Mr. Newcomb's paper consisted largely of innumerable details it is impossible in limited space to do justice to those details, but there may be mentioned one thing which became apparent as his pictures and discussion progressed, namely, a rather amazing degree to which early homes conformed to conditions of climate, family and social habits, and availability of local material. Finding their origin usually in European sources, house designs were quickly modified to meet quite accurately the new environment, and it is rather remarkable how well the artistic aspect of architecture was served by pioneers engaged in conquering a new land. With some exceptions utility was well served with dignity and grace.

Although Mr. Newcomb did not draw any moral, the one apparent to his listeners was a challenge to the engineers, architects and home economists to meet the conditions and requirements of the present and future with as much efficiency, common sense and good taste as our forebears exercised in their time and circumstances. There is particular need for conscious effort along sound architectural lines, when manufactured mill work makes easy the perpetration of architectural crimes, and where the marketing of ready-made homes over a vast area presents the danger of shipping to North Dakota a design adapted to Louisiana, or vice versa.

It should be noted also, as pointed out by Mr. Newcomb, that historically there often was no great distinction between farm and urban homes, largely because newly settled countries are predominantly agricultural.

W. A. Foster, assistant professor of rural architecture, University of Illinois, in his paper, entitled "Combining Utility and Beauty in the Farm Home," was concerned chiefly with the need for more attention to the beauty element in farm home design, pointing out that all of us, even those not trained in nor consciously concerned with beauty nevertheless are largely influenced in our happiness and efficiency by the artistic element in our environment. The beauty, or lack thereof, of the farm home has much to do with the contentment and morale of those who live in it and with the respect of those who pass by.

Of the three basic principles underlying architecture—fitness, strength and beauty—the first two are well taken care of, at least relatively, in the farm home through the efforts of agricultural and other engineers and home economists, to-

gether with the common sense and accumulated experience of farm people themselves. Beauty, the third principle, has been all too largely neglected or forgotten. Architectural treatment of the farm home has been left to the carpenter and contractor with results not quite so bad, perhaps, as might be expected. The achievement of beauty in structures is distinctly an art, and is most likely to be accomplished by specialists trained to that end.

Beauty is found in materials, much as color or texture; in form and mass or in the expression of the structure as produced in character, association or material. The three divisions of a building are the walls, the roof and the openings, mass and shape being determined by the first two, while the effect arises from the openings, their shape, proportion, grouping and added ornaments or decorations.

The farm house has become an individual problem, and often a rather difficult problem. The utilitarian and economic demands often are exacting. Not only is it a problem to clothe these practical essentials in beauty, but the problem is quite different from that of the city or village house. Instead of being closely associated with others of its kind the farm house is situated in the open, to be viewed from considerable and varying distances. It should be in keeping with the terrain, whether it be the bare sweep of the prairie or woods, streams and hills. It is associated also with the other structures of the farmstead, which it should not resemble, but with which it must be compatible. As regards room available on the site the farm home is much more advantageously located than a city home of corresponding size and value, affording the architect more freedom for an artistic creation, and at the same time making more conspicuous any lack of or improper adjustment to the setting.

Before beauty can take its proper place in farm home design the farmer himself must be stimulated to a craving for that beauty, educated as to the way in which it may be obtained, and sold on the idea that it is worth a reasonable cost. The agricultural engineer and the home economist have an opportunity to assist in this, and also in direct cooperation with the professional architect in creation of specific designs. A large burden of responsibility lies on the architectural profession, which heretofore has neglected the rural field as unappreciative and unremunerative. The architect must have training and sympathy for the special requirements of the farm home and its setting.

In the discussion which followed there seemed to be a disposition for the engineers to admit as true the charge that they design buildings which are efficient but ugly, and there was a rather general opinion that material improvement in this respect can come only through the architectural profession getting into the field and contributing its side of the triangle as the engineers and home economists are trying to contribute theirs. Miss Gray, however, admitted with regret that the home economics people had worked largely with food and clothing, to the comparative neglect of housing, and this she said was particularly unfortunate, because a mistake in selecting food can be corrected the next day, an error in choice of clothing rectified the next month or the next year, while a blunder in creating a home has to be lived with for a lifetime.

Need of Research to Determine Basic Requirements of Farm Buildings Stressed at Structures Meeting

STRANGE as it may seem, farm structures are almost without foundation, according to the paper, entitled "Determination of Basic Requirements of Farm Structures" by M. C. Betts, architect, U. S. Department of Agriculture, presented at the meeting of the Structures Division of the American Society of Agricultural Engineers, at Chicago, December 1 and 2.

The phase of the agricultural industry in which there has been very little development in recent years is the shelter essential, notwithstanding that agriculture has spent vast sums of money for buildings, much more than for machinery and equipment. It is more important than ever that farm structures be well engineered, both because the farmer's time is worth more than ever before and the influence of building design in conserving that labor correspondingly more significant, but because the materials and labor required in the construction of building are more costly and should be employed with utmost intelligence.

Yet farm buildings of today differ but little from those of fifty years ago and, except in a few respects, from those in a much earlier age. It is said that at least some of our farm buildings cost too much, but this can be neither sustained nor refuted without knowing the contribution which those buildings make to farm production; without knowledge of the influence of building costs on other production costs; without knowing the point at which building investment gives a lower return than similar investment elsewhere in the enterprise, etc.

The question as to wherein our farm structures fall short in many, perhaps most, instances cannot be answered because we do not have a proper measure of performance, a definite knowelge of the requirements and means of determining the extent to which those requirements are met. We know that storages for certain crops are by no means entirely successful because there are heavy losses in storage. We do not know the remedy because we do not know definitely the conditions under which the crop must be stored for best results. We do not know wherein our dairy barns may be at fault because we do not have definite information as to the temperature, humidity and other environmental conditions making for greater production of milk, nor what arrangement, under varying conditions of location, climate and practice, makes for greatest efficiency in management.

Owing to the public demand for information nearly 30 per cent of our agricultural-engineering extension workers devote their major efforts to farm structures, and most of them have had to develop subject matter from existing common practices since practically no research of a basic nature has been done. A rough estimate indicates that six times as much effort is being placed on extension work as research, but this ratio must be changed so that the extension worker may be supplied with proven facts if there is to be progress in farm structures.

Boardly the research problems with which we are confronted are of two classes, those involving determination of structural requirements essential to productiveness and efficiency, and those looking to determination of the means whereby such requirements may be met.

Mr. Betts discussed in considerable detail the subjects which should be investigated and determinations made, somewhat in their order of importance and approach, as follows: Space requirements, arrangement for efficiency and economy, temperature, humidity, ventilation, light, sanitation and water supply, selection of materials, structural design, and equipment.

Even in structural design where much more already is known than in the basic requirement which the structure is required to meet, there is vast room for improvement. We have arrived at a point where strictest economy is essential. We cannot afford either the achievement of strength and durability by the extravagant use of materials and labor, or yet can we afford failures due to unscientific economy. It may be that in relation to life and property hazards involved we are employing factors of safety unnecessarily high.

It is much easier to state the problem than to attack it successfully. Mr. Betts proposes that all research agencies available for work of this sort be employed and others be enlisted as the need for and value of such research becomes more apparent, but that all work of this character be so correlated that duplication be avoided and results made compar-

able. There are now very few state agricultural experiment stations where research work in structures is possible, but with a definite program it may be that other colleges will find it possible to provide men qualified to carry it out, if they can be found. It is suggested that there be set up a series of projects designed to bring out the desired information beginning with dairy structures and following with housing and equipment pertaining to poultry, swine, beef cattle, grain, fruit and vegetables, depending somewhat on their importance geographically and economically.

In any event there should be a central correlating agency. As a beginning, or point of departure, the committee on Research Development of the Structures Division submitted at the conclusion of the paper a sample project statement in outline form. This one might be designated as Project No. 1, covering determination of space requirements in dairy barns. It would call for cooperative work by departments of dairy husbandry and agricultural engineering. Object, procedure, and organization were briefly outlined, not so much as a recommended method of attacking this particular problem, but as a specific example of a general method whereby desired projects might be set in motion.

In both the scheduled and volunteer discussions following the paper by Mr. Betts, and also in the round-table discussion the following afternoon, the consensus seemed to be that the program as proposed was highly important and correct in the general plan of procedure suggested. Considerable attention was given to the question of just where and how the initial attack should be made on so large a proposition. Important among these considerations was that of cost, including on the one hand possible and proper sources of research funds, and on the other suggestions as to correlation measures whereby structures erected for other purposes may be made to serve research ends at comparatively little additional cost.

B. M. Stahl, agricultural engineer, Ohio State University, called attention to the disproportionately small percentage of experiment station research workers giving their efforts to structures, emphasizing this lack of proportion by comparison with the relative farm investment in lands, buildings, machinery, etc. He mentioned also an apparently growing public acceptance of and demand for real research, citing as an example a resolution by the national Grange convention asking that more fundamental research be done instead of emergency research. With respect to sources of funds, Mr. Stahl mentioned the willingness of various commercial interests, notably manufacturers associations, to contribute to research projects where these gave reasonable promise of bringing to light facts of commercial value, and in that connection said that only a few of the land grant colleges had well-defined policies governing the acceptance of research funds from external sources and the procedure of research so provided.

The prepared discussion by F. P. Cartwright, chief engineer, National Lumber Manufacturers Association, expressed the sympathy of the lumber interests for the general program laid down by Mr. Betts, and signified the willingness of those interests to do their part in a research program. In the particular field of lumber Mr. Cartwright mentioned as profitable subjects for research quantitative studies of decay hazards and their elimination, determination of optimum moisture content in lumber, protective properties of paint, fire-retarding treatment of lumber, and more adequate determination of the insulating values of various kinds of wood.

H. B. White, agricultural engineer, University of Minnesota, sounded a more optimistic note by pointing out that the apparent backwardness of progress in structures is due to the longer life of buildings as compared with other equipment, hence the survival of obsolete and inefficient structures. He indicated also that structures research is beginning to come into its own, mentioning that there are now 112 projects in progress.

C. S. Whitnah, agricultural engineer, King Ventilating Company, contributed a short discussion from the standpoint of the barn equipment manufacturer, emphasizing the importance to these interests of temperature and humidity influences, arrangements for convenience and efficiency, and effect of light. ,

Another commercial viewpoint was presented by G. L. Bennett, engineer, Sheet Steel Trade Extension Committee, who set forth the commercial axiom that one requirement of research is reward; for example, the automotive and aviation industries, as examples of interests with a promising future, have made tremendous progress through research in very short periods of years, while there is no research in horseshoes or candlesticks, and what is just as significant, little or no research or progress in industries which have been wrecked by destructive competition. The commercial executive is not much interested in research data to be brought to light ten or twenty years from now, but can be interested in a research program of comparatively short duration directed toward a definite objective.

John Swenehart, agricultural engineer, University of Wisconsin, emphasized what he designated as the economic engineering problem, which he feels is fundamental, and mentioned a project being started along that line at Wisconsin, which is expected to get to the bottom of things regardless of the number of years it may take or how far outside the boundaries of the state it may go. He advanced also a plea that whenever state buildings are erected, whether on the experiment station farms or at other institutions, the opportunity should be given for structures research to be carried on, as usually this could be done at little additional expense if cooperation and correlation were accomplished at the right time.

F. C. Fenton, agricultural engineer, Iowa State College, emphasized the importance of cooperating in structures research with the farm management people and, as Mr. Swenehart had mentioned, the animal husbandry men. As specific instances of research support by commercial interests he mentioned the studies at Iowa involving the development of an arched barn in hollow tile construction, financed by the hollow tile interests, also the expressed willingness of insurance men to finance research which would reduce their losses on barns blown down by tornadoes. Mr. Fenton believes that engineers need not go out of their way to consider the economic aspect, saying that he was "not worrying about spending too much money for farm buildings, because there are so many other forces opposed to that. The natural economy of the farmer and the desire and the tendency for cheap construction are almost insurmountable obstacles."

C. P. Tobin, sales engineer, the Cellotex Company, emphasized chiefly the fact that industries can and will support research projects looking toward the answering of specific, pertinent questions within reasonably short periods, and he was followed by H. B. Walker, agricultural engineer, Kansas State Agricultural College, who supplemented that viewpoint by saying that any research work of sufficient importance to require the time of the experiment stations should be able to stand on its own merits, receiving its support from regular experiment station funds the same as any other branch of research. Mr. Walker holds that short term investigations of commercial significance should properly have the support of commercial interests, but that in the search for basic facts, involving long periods of time and with no close relation to any one industry, the work should be undertaken by the experiment station on its own initiative and expense.

E. C. Kerth, chief engineer, Hollow Building Tile Association, briefly emphasized the importance of coordination in a research program, stating that the coordination of his industry with sectional groups, colleges, research institutes and even private testing laboratories has brought out things which had been sought for years.

A contribution by L. B. Lent, engineer, Common Brick Manufacturers Association, proposed as being worthy of study under the proposed research program an idea advanced by L. E. Hazen, agricultural engineer, Oklahoma Agricultural College. Some of the outstanding features of the Hazen proposal are that the major buildings be combined in one group to enhance efficiency in operations and minimize sidewall construction; that construction be of inflammable material but separated by fire walls. Mr. Lent added the suggestion that single story construction be favored as being both cheaper to build and more efficient in operation.

Muscle Shoals as Engineers of the South See It

By E. A. Stewart[1]

THE construction, operation and use of Muscle Shoals is a very interesting problem for the engineer. The disposition of this government-built plant is of interest not only to all engineers but to farmers and taxpayers in general throughout the whole country. The Muscle Shoals dam, power plant, and the nitrate plant were built under the National Defense Act and their construction was started shortly after this act was passed about 1916. At that time the purpose of building the Muscle Shoals power plant was two-fold—to provide nitrate for explosives in times of war and for fertilizer for the agricultural industry of America in times of peace. At the time this plant was proposed and developed this two-fold use of the power plant was in perfect harmony with engineering and scientific information available at that time. The wonderful advance of science during the interim period from then until 1927 has changed the situation very materially.

While in attendance recently at the Southern Appalachian Power Conference, at Chattanooga, Tennessee, I had an opportunity to hear from engineers, statesmen, and political leaders of the South their idea as to what disposition should be made of the Muscle Shoals power plant at the present time. This plant has not been used for much of any service during the past seven years, while its disposition has been held up in Congress pending an agreement upon what should be done with the power developed at this plant.

A very large group of farm leaders in Congress have been and appear to be still maintaining that the power at Muscle Shoals should be used for the production of fertilizer and that because this plant is owned by the government these fertilizers should be produced at a low cost for the farmers of America. On the other hand, there has been a very large group of congressmen who have maintained that the power at Muscle Shoals should be used as electrical power for industries of the southeastern part of the United States. Since this problem is of interest to all of the people of the United States, its disposition will depend to a large extent upon what the people of the various parts of the country want to have done. Whether the disposition that is eventually made of Muscle Shoals is a wise one for the country will depend upon how much information of the correct type is available for people in the different parts of the country.

The attitude of most of the South is very well summed up in the statement made by Senator S. M. Sackett of Kentucky who has served on the joint committee of the House and Senate which has considered bids for the Muscle Shoals project during the last session of Congress. He said, "The two-fold purpose for which the power unit was constructed by the government—the manufacture of nitrogen for war munitions and agriculture—is no longer of primary consideration in its disposition, inasmuch as the present trend in nitrogen production is away from the use of electric power in any quantity at all and toward processes that depend on the gasification of bituminous coal." Mr. Sackett urged that the power plant be leased to some private enterprise that would be capable and willing to pay the government a reasonable return on the enormous outlay incurred in its construction. He stated that it was a misguided movement to delay the hydroelectric development of the southern section until the question of the production of nitrates for fertilizers is settled.

Former Congressman John H. Small of North Carolina expressed a very similar opinion to that expressed by Senator Sackett. He said, "In the light of today's knowledge of nitrate production this demand for utilization of Muscle Shoals for fixation of nitrogen is almost whimsical. It is held up as a club to hold back this development of the upper Tennessee River, and this whole region is retarded. It is an injustice to all these southern states that are held back by this agitation. It is an unnecessary infliction of injustice upon the state of Tennessee and upon the southern Appalachian states. Let us proclaim the truth, and if we do it with sufficient repetition and do it often enough and use the language of truth, we can convince the farmers of the country that we are trying to serve them, and we can convince Congress that the reason for the original national legislation has been removed, that Muscle Shoals and hydroelectric power is no longer a factor in the production of nitrates."

During the discussion of the Muscle Shoals problem Harrison E. Howe, editor of "Industrial and Chemical Engineering," gave a very interesting talk on the production of nitrates and the change in the methods of production that has taken place in the last few years. He pointed out that the arc process for the production of nitrogen required about 67,000 kw.-hr. per ton of nitrogen, that the cyanimide process required about 14,000 kw-hr., and that the new synthetic ammonia process required but 4,000 kw.-hr. He pointed out the further fact that the synthetic ammonia process required coal, and since the 4,000 kw.-hr. of energy that are required for this process do not necessarily have to be electrical energy and can much more properly be heat energy from coal, that it was more necessary to place synthetic ammonia plants in close proximity to a proper supply of coal than it was to place them in proximity to hydroelectric power. Mr. Howe also gave facts to show that the trend in the production of nitrogen has been very materially away from each of the first two processes and is now rapidly developing by the synthetic ammonia process. He gave figures to show that, while in 1920 a very large majority of the nitrogen was produced by the cyanimide process, by the present year the few plants which are now in operation with the synthetic ammonia process have produced more nitrogen in the past year than all of the other types of plants combined. He also showed how more than two-thirds of the cyanimide plants which were in use in 1920 have discontinued operation in 1927. The fact was also brought out that the synthetic ammonia process enables the manufacturers to produce nitrogen at a cost which is undoubtedly lower than the cost that could have been reached by the production of nitrates at Muscle Shoals by the older processes, the cost of nitrogen by the synthetic ammonia process being about $221 a ton while the cost per ton of nitrogen for fertilizer imported from Chili amounts to about $300 per ton.

In summing up the situation Dr. Howe said, "These fundamental criteria have convinced the scientists and the engineers qualified to judge that the allocation for any considerable period of a substantial part of Muscle Shoals power for manufacture of fertilizer will be wholly unjustified and little short of criminal. There is nothing disgraceful and no indication of breach of faith in saying frankly to the farmer, who is made to believe that the operation of Muscle Shoals will reduce his fertilizer bill anywhere from 25 to 43 per cent depending upon the imagination of the farmer, that since the original bills were passed the progress of science has changed the picture and that for the same reason the farmer is sure to be able to buy nitrates, thanks to synthetic ammonia, for less in the future than in the past."

In order to perhaps satisfy the farmers that the investment of the taxpayers' money in Muscle Shoals would still benefit them to some extent in the fertilizer industry, Dr. Howe made a very happy suggestion. He said: "If a political situation has been developed through persistent misinformation given the farmer, then careful consideration should be given to the recent suggestions. The idea may be sound that Muscle Shoals should be leased on a basis that will yield the greatest return to the government and that this return be then used for the production of fertilizer by the most advanced method at points chosen as the most suitable without that choice be influenced or hampered either by tradition, prejudices, or politics."

The situation in regard to Muscle Shoals and its disposition can be fairly well summed up by quoting the resolution

[1]Associate professor of agricultural engineering, University of Minnesota. Mem. A.S.A.E.

on this subject as adopted at the meeting of the Southern Appalachian Power Conference. This resolution is as follows:

"Years of poorly recompensed labor have been spent by the Congress in the attempt to dispose of Muscle Shoals. There appears to be no reasonably certain legislative prospect that the end is in sight. In the meantime great power developments in the Tennessee River basin, urgently necessary to the continued well-being of a great region of the South, are being held in a state of suspension. Without entering into the merits of the controversy it may be said that the major premise on which the legislative contest has been waged is the provision of the National Defense Act that the Muscle Shoals property shall be operated for national defense purposes in times of war and for the manufacture of fertilizer in times of peace. The manner in which this provision of law shall be obeyed has been provocative of more prolonged debate and recrimination than is usually given to national matters of far greater public concern. It is now manifest that the fundamental defect in this matter is that the legislative procedure has lagged far behind commercial progress throughout the world in the science of nitrogen fixation. Unless it may reasonably be inferred that our foremost scientific authorities on nitrogen fixation matters, including those of the United States government, have entered into a conspiracy to deceive the public, we are constrained to accept their assurance that the Muscle Shoals nitrate plants are obsolete and their operation for the manufacture of fertilizer would be of no advantage to the American farmer. We do not feel warranted in minimizing their testimony nor can we fail to note the testimony given before the House Committee on Military Affairs on February 19, 26, and 28, 1927, by the Secretary of Agriculture, the chief of ordinance of the U. S. Army, and the director of the U. S. Fixed-Nitrogen Laboratory. That testimony, which has been broadly distributed under the authority of Congress is, in brief, that Muscle Shoals no longer occupies its former importance as an agent of national defense and that its only present usefulness in that respect (the oxidation of ammonia to form nitric acid) is transitory; that better and cheaper ways of making commercial fertilizer than that set up at Muscle Shoals have been demonstrated and are in successful operation, and that the United States cannot productively operate or contract for the operation of the existing plant.

"Unless this official testimony as well as that of the foremost civic authorities be discredited, it seems evident that the difficulty of Congress is that it has been trying to breathe life into an obsolete process in order to give effect to an obsolete law. If this be correct, we can visualize no reason why an obsolete law with respect to Muscle Shoals should be accorded any different legislative treatment than an obsolete law with respect to any other matter. This does not mean abandonment of Muscle Shoals as an agent in promoting sources of cheaper and better grades of fertilizer. The necessity for larger and less expensive sources of ingredients for fertilizer to the American farmer is conceded. There is merit in the suggestion of the Secretary of Agriculture that Muscle Shoals remain dedicated to the farming industry, by deriving therefrom an adequate income from the hydroelectric power and by devoting that income to the promotion of cheap fertilizer, according to modern successful methods both at Muscle Shoals and elsewhere in other fertilizer-using regions. Such a plan would not only serve the farming industry but, in conformity with our previously expressed position concerning the decentralization of industry and the general distribution of power in the furtherance thereof, would make such disposition of Muscle Shoals power as will provide for its widest and most diversified public use."

Agricultural Engineering Features State Fair Exhibit

By J. C. Wooley[1]

FOR some years past it has been the custom at the University of Missouri to appoint one department to have charge of the institution's state fair exhibit each year. The department appointed has the privilege of the center location for their exhibit, and all others build theirs to fit in and contribute to this central exhibit. This year the agricultural engineering department was given the premier position and placed in charge of the exhibit. Fourteen other departments cooperated in contributing to the University's exhibit.

The extension projects on land reclamation and on home conveniences, together with our research project on rural electrification were given the most prominent place in the exhibit.

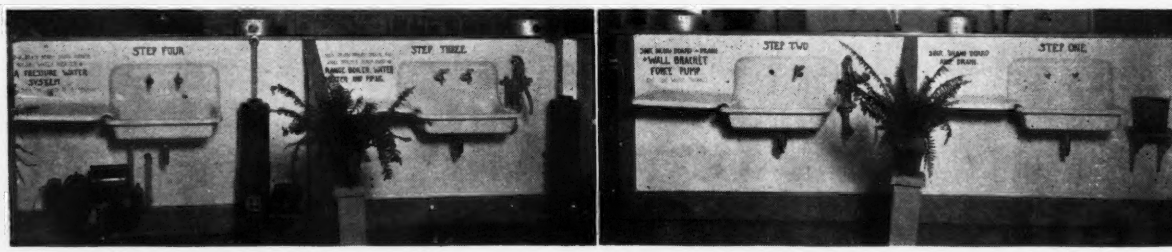
Prof. Frank D. Paine's cost meter was secured and used as the nucleus for one very instructive and attractive booth.

The land reclamation booth contained two miniature fields, one with stumps in it, and one that had been cleared. An accompanying chart gave data on the cost of clearing and on the losses in crops, machinery and time that occur when the farmer farms around the stumps.

The third booth illustrated the four steps in building up a water system for the farm home. (See accompanying illustration.) Starting with a sink, drain board and drain the first year a system can be built up without loss or inconvenience and with a desirable distribution of costs. The addition for the second year is the wall-bracket force pump. The third step is the hot and cold water equipment. The fourth step, the pressure system, makes the force pump unnecessary. Our extension specialist usually urges that the old pump be sold to a neighbor who is starting to build a system.

While the results which are derived from such an exhibit are intangible, we believe they are worth the two months of hard work necessary to arrange an exhibit of this kind. A count was made of the visitors to the building on University Day at the fair. It showed that 10,028 people visited the exhibit on that day. The question "What is Agricultural Engineering?" is seldom asked any more. We think this is a good sign, and we believe that the exhibits have helped.

[1]Professor of agricultural engineering, University of Missouri. Mem. A.S.A.E.



This picture shows the four steps (from right to left) in the Missouri plan for progressive water system installation

Electric Refrigeration And Its Agricultural Uses*

By W. T. Ackerman[1]

MANUFACTURERS of electric refrigeration machines have made such generous use of advertising in their efforts to acquaint the American public with this modern method of preservation of perishables, that it is hardly necessary to introduce these appliances. The variety of uses to which these machines have been adapted in the past few years is rather remarkable. City homes and city enterprises were the first to enjoy the benefits and during the increasing popularity of this equipment the agriculturist and rural dweller has, for the most part, had to be content with the older method of using natural ice. The delay in the entrance of the equipment into this field is probably due largely to three causes. First, the city business offered the greatest remuneration and probably advantages in uniformity of type and style of equipment required. Second, dependable electric service, which is a prerequisite, has not been common in the rural districts. Third, manufacturers were not acquainted with the requirements or agricultural applications.

The last few years have seen considerable progress made in the study of the relation of electricity to agriculture with the result that extension of central station electric service into the rural sections has increased tremendously, and it is estimated that within the next twelve months the construction of rural service lines will be even greater.

The experimental work, which forms the background of this paper, has been a part of the New England project on the relation of electricity to agriculture, known as the "New Hampshire Project," carried on by the University of New Hampshire Experiment Station, and, therefore, more directly reflects New England experience. The data given should be considered more in the sense of a report of progress than as a completed experiment.

Of the many profitable uses to which electricity may be put on farms there is probably none which arouses greater interest, where considerable quantities of ice are used, than mechanical refrigeration. It is more or less surprising to many that this should interest the farmer who is popularly supposed to have all the ice which he wishes to use at practically no expense. To attempt to discuss the methods and procedure of natural ice harvesting, storing and handling is uncalled for, but to outline sparingly some of the points in this procedure will serve to show wherein the purchase of such equipment is justified in many cases.

Most New England farmers assert that they generally have time, help and equipment for harvesting natural ice during the winter without any particular difficulty or hardships other than those which would naturally accompany ice cutting in cold weather. The entire operation of cutting and storing can generally be easily completed in a working week, even allowing for some bad weather. That this part of the work can be hazardous, however, is set forth by one farmer among the experimental group who recalls a winter when he, his team, and a full sled of ice crashed through a current hole while drawing ice from the nearby river.

The place where the electric refrigeration machine gains its greatest foothold is in eliminating the almost daily necessity during the spring, summer and fall months of digging the ice out of the icehouse, cleaning it down, carrying it or drawing it to the ice boxes or cooling rooms and loading these bunkers. If the farm uses considerable quantities of ice, such as a dairy farm using three or four hundred pounds, say, every other day, it takes considerable time to perform this task. For the farm which uses only a small amount of ice, usually in the household refrigerator, nearly as much time is required. Moreover, it is usually difficult to get the men about the place to do it at the right time, foods get warm or spoil, and there is general discontent about the quality of the meals, etc. In other words, the most important consideration is the fact that the electric refrigeration machine removes entirely from everybody's mind the ever-troublesome and sometimes very expensive question of getting the ice at that time of year when there seems to be twice as much to be done as there is help to do it and the little odd chores are a drag on everybody's shoulders.

Electrical refrigeration can be put to several uses. Dairy farmers are found to be the first to be interested in this equipment to provide efficient storage for either wholesale or retail milk before delivery. In fact, it is generally the case that the farmer is interested in equipping the commercial side of his farm first. The second step is generally to add equipment to chill or precool the milk immediately after milking. Perhaps at the same time there is an equal amount of interest, in this case on the part of the whole family, in electric refrigeration for household use.

Two types of equipment may be used for the storing of milk and cream. The first is what may be termed a dry storage, consisting of a refrigeration unit operating in a compartment with air as the medium of cold transmission from the brine tank to the stored milk and cream. This is the equipment and method which has been used by the New Hampshire project. Where such a type of equipment is used, it is necessary and essential that the milk be precooled before placing it in the cold storage. Due to the low rate of interchange of heat and cold where air is the medium of transmission, it would take an unreasonable length of time to reduce the milk from body temperature to the temperature of the cold storage. Based on the rate of bacterial growth it is standard practice to reduce the temperature of the milk to as near 45 or 50 deg. F. as quickly after milking as possible. It will be observed, then, that in this method the cold room is strictly a cold storage, and the precooling of the milk is a separate step, which, however, may be accomplished by using the same equipment provided it has sufficient capacity. This is done by connecting the brine tank of the refrigeration unit with a tubular, spiral cone or some other practical form of surface cooler, through which the brine is forced by a circulating pump, the milk being poured over the outside surface. To reduce the load on the compressor unit, it is usually possible to circulate cold well water, if available, through one-half of the cooler and brine through the remaining half. As many farms in this section have very cold well or spring water available, it is sometimes equally as practical to utilize the water alone for chilling the milk. This also has the advantage of avoiding some possible complications which may be encountered if the brine is used and has the very decided advantage of simplicity.

A second method of storage is what may be called a wet storage and consists of an insulated tank, usually of concrete, filled with water to the proper level. A refrigeration unit is connected to this tank so that the expansion coils are immersed in the water, the temperature of which is maintained at the desired point. Milk and cream, usually in cans, are then dropped into the tank.

This method is intended to accomplish both the precooling of the milk as well as to provide a cold storage before delivery or shipment. In this case water is the medium of exchange of heat and cold which is considerably quicker in action than air. It requires, however, something like 14 hr. to reduce the temperature from 95 deg. to 40 deg. F., if no agitator is used. As it is generally impractical to attempt to stir or agitate the milk by hand, a method has been developed whereby the milk may be cooled as it is poured through the

*Paper presented at the 21st annual meeting of the American Society of Agricultural Engineers, at University Farm, St. Paul, Minn., June, 1927. Contributed by the Rural Electric Division.

[1]Project leader and field engineer, New Hampshire Project on the Relation of Electricity to Agriculture. Mem. A.S.A.E.

strainer into the can. It is expected that in this manner the time required for precooling will be reduced. The wet storage just described has been developed by the Adirondack Power and Light Corporation, of Schenectady, N. Y., and up to the present time the New Hampshire project has not carried on any experimental work with this type of equipment.

Which of these two types is used or will be the most satisfactory is probably an open question and a matter for the individual to decide, after considering his own local conditions and requirements. However, a comparison of the two types may show certain advantages and disadvantages in each case and indicate which is the more practical for a given purpose.

The dry type may be used for milk in cans or bottles, for food, meats and almost any perishable product. The wet storage is largely confined to the storage of milk in cans only. It is not suitable for milk in bottles or many other products.

In the case of milk handling, particularly, either type may accomplish both precooling and storage using the same equipment to which must be added supplementary surface coolers to reduce the time required and meet regulations of milk companies, boards of health, etc.

Dry conditions are superior in many respects to wet conditions, principally from the standpoints of mold growth, sanitation, contamination, deterioration or decay, as well as avoiding the disagreeable task of handling under wet or sloppy conditions which most farmers are glad to be rid of.

Limited quantities of ice may be manufactured with dry type machines for emergency or special use. This is not possible with the wet type.

The construction of the dry room is believed to be easier than the wet tank and is less restricted as to desirable location. Either type can be built with local or home labor if directions are supplied. The size of either may be as desired.

The dry storage is probably somewhat easier to work in and out of, particularly if built large enough to walk into.

If located within a reasonable distance of the kitchen, one dry storage plant may serve two purposes, i.e., the home, as well as the dairy, by constructing a cabinet in it for foods.

The dry storage cannot be damaged by accidental freezing, either as regards the compartment or the mechanical unit, if an air-cooled compressor is used.

Comparative costs of construction are not available just at present, but these will be affected most by the size of refrigeration unit required. It is believed that for a given purpose the cost of a dry storage may be somewhat greater than the wet type, exclusive of precooling equipment.

Figures on the cost of operation are not at present available for the tank type but will be given later for the dry storage.

The Dry Storage Cooling Room. The construction of the cooling room may be accomplished in one of several ways, inasmuch as the first step is to provide four supporting walls with a ceiling and floor. For this purpose an old ice-cooled storage, if of suitable size, may be converted by the addition of insulating materials as will be described later. Another method which can sometimes be used is to start with a corner in some room or building which will usually furnish two sides, the ceiling and floor, and will, therefore, require the construction of only two remaining sides to get the desired size. The third method, and many times the most satisfactory, is to construct an entirely new room to the desired dimensions.

The walls referred to, if constructed new, should have 2-by-4 studding, spaced 16 or 18 in. on centers and then be sheathed inside and out with matched boarding. In one wall, space should be framed to take a standard insulated refrigerator door and frame which is best purchased already constructed. The manufacturer will furnish the necessary instructions and dimensions. The standard opening is 3 by 6 ft.

The entire inside surface of the room is then covered with two thicknesses of insulating paper. Over this an insulating wall of 4-in. cork, in slabs, is nailed. These slabs measure 12 in. wide and 3 ft. long. All joints are broken and made tight by the application of hot asphalt just before being put

Mr. Ackerman says it is not uncommon for cooperators on the New Hampshire rural electrification project to say, "One thing we are certainly going to keep is the house refrigerator." The electric refrigerator is the source of a great deal of satisfaction in the farm home

in place. It is necessary to carefully fit each piece in order to avoid through leaks. After the cork is applied to the entire inside surface, including the floor, the walls and ceiling should be given two coats of a portland cement finish to total a thickness of ½ in. Provision should be made to allow at least a 2-in., and preferably a 3-in. concrete floor, laid with a slight slope toward the door. This will allow the water to run out when the room is cleaned or sluiced down. The interior may then be painted white which improves it in both appearance and light-reflecting qualities. The room is now ready for the installation of the refrigeration equipment which should be done by the company selling the same.

The cost of a newly constructed room on the New Hampshire project, measuring 5¼ ft. square by 6½ ft. high, using one local carpenter and the farm help, amounted to $234.50 for materials and labor. At the same time a quotation of $335, on a room 6 ft. square and 8 ft. high was quoted by a cork insulation company. This quotation, however, required that the supporting walls be already constructed and ready for the installation of the insulating materials. The most difficult part of the entire operation is applying the coatings of rich cement to the cork walls. This can be made considerably easier by first screening the cork surface with 1-in. mesh chicken wire.

A similar procedure as that given above is followed in converting an old cooling room. There are several abbreviations of this method which give quite satisfactory results, and lessen the expense of construction somewhat. The above, however, is approved as standard refrigerator construction.

The total cost of such a cooling room as described, with refrigeration equipment installed, will vary according to the method employed in constructing the room, assuming that the cost of the mechanical equipment remains the same. The newly constructed room on Farm No. 4, with mechanical equipment installed, ready for operation cost $766.50. The converted room on Farm No. 1 cost $705.25, which includes the original cost of the old ice room and the unit installed ready for use. Exact cost figures on the cooling room on Farm No. 2 are not available, but it is believed that the expense was $50 to $75 less than that of Farm No. 1, or somewhere in the neighborhood of $625 ready to operate. The point where the farmer may effect a considerable saving is in constructing the room himself, which, as indicated

previously, is not too difficult a proposition when furnished with the necessary directions and instructions.

The soundness of an investment of $750 to $800 in a dairy cooling room would have been immediately questioned a few years ago. Results thus far obtained in the experiment indicate promising possibilities of this equipment paying for itself, at least on retail dairy farms, in less than five years and then paying a dividend for several years, if well-built, sturdy equipment is used. Probably a greater number of factors enter into the arrival at this conclusion than with other types of equipment with which we are accustomed to deal. The most important factor is the almost entire elimination of labor in all phases of the work. This, then, is not an attempt to justify a large investment in equipment, but rather to point out the necessity of measuring the practical value of such an electrically operated device by a somewhat different standard.

The cost of operation is considered very moderate. In the winter months when the machines are shut down and natural temperatures are utilized, the cost of operation is, of course, zero. On the other hand, taking the maximum as given for Farm No. 1 of 226 kw. for one month, the cost of operation would be $9.04 on a 4-cent rate, or $18.08 on an 8-cent rate. The more efficient room on Farm No. 2 would cost $6.56 on a 4-cent rate, or $13.12 on an 8-cent rate.

TABLE I. Dairy Cooling Room Records on Experimental Farms

Farm number	Quarts stored	30-day periods approximately—kilowatt-hours			Extent of record
		Min.	Max.	Av. 8 mo.	
1	300	0	226	96.5	April to December '26
2	300	0	164	112	August '25 to December '26
4	300	0	175	148	April to December '26
Average	300	0	188	119	

Taking the average of the three cooling rooms, 119 kw.-hr., the average cost per month, during a period of eight months, would amount to only $4.76 at 4 cents, or $9.52 at 8 cents. Using this same figure of 119 kw.-hr. as the average per month, the total cost of operation for the eight months would be $38.08 at 4 cents, or $76.16 at 8 cents per kilowatt-hour. Exclusive of considerable labor, ice on a dairy farm may easily cost $250.00 to $300.00 a year.

One cooperating farmer feels that he pays his current bill each month in the milk and cream which is saved from spoiling when necessary to hold it over another day. Another states that the general quality of his milk is so much improved that he pays for the current in the elimination of trouble with his customers. Another brings out a similar point and believes that he easily pays for the cost of operation in that his milk spoils less quickly at the customer's home, and he has no difficulty in finding a market which is willing to pay slightly more for this advantage. There are numerous other ways in which the cost of operation may be said to almost take care of itself.

Refrigeration Units. It is quite evident that in a room of such a size as referred to, containing 180 cu. ft. contents, considerable attention and care should be given the selection of a refrigeration machine to secure one of sufficient capacity and sturdy construction to provide satisfactory and uninterrupted service. The three cooling rooms operating in the project are all equipped with the same size and make of refrigerating machines. This is a two-cylinder, reciprocating compressor, gear driven by a 1/4 or 1/3-hp. motor and automatically controlled by a mercoid thermostat. The compressor and condenser coils are air cooled by a fan attached to the motor shaft. Air cooling, while not as effective as water cooling, has been insisted upon because of the variable conditions of water supply and pressure which are bound to occur on farms. Any difficulties from freezing, leakage, etc., are also avoided. Methyl chloride is the refrigerant used. The price of the equipment exclusive of the brine tank is $325. Brine tanks vary in size according to the requirements of each installation but can be expected to be within the neighborhood of $100. These quotations are installed prices.

Dairy Cooling Rooms on the Experimental Farms. Three of the four dairy farms used in the project are equipped with cooling rooms. The following extracts from a recent printed report on the project (Bulletin No. 228, New Hampshire Agricultural Experiment Station) gives briefly a description of each of these rooms. The average current consumption recorded during the experiment is shown in Table I:

"Like the household refrigerator the dairy cooling room, chilled by electric refrigeration machines, has been pronounced practical and successful by the three dairymen who are using them. The plan used in the experiment was intended primarily for retail dairymen who handle bottled milk, but has since been tried by several farmers handling milk in cans. * * * * * *

"* * * * The units used have been found particularly efficient and ruggedly constructed as is evident from a comparison of their size and the size of room which they are chilling. One of these machines has been operating for three years, and the other two for one year."

"Farm No. 1. This room measures 4½ by 7 ft. by 6 ft. high. The walls and ceiling have two air spaces, 3 in. of cork insulation, and ½ in. cement lining. During the past season an uninsulated, concrete floor was used. The room, converted from an ice cooler, is in the basement and stores 300 qt. of milk daily.

"Farm No. 2. This cooler measures about 4¼ by 5½ ft. by 6½ ft. high, and was converted from an ice-cooled storage by the addition of cork insulation varying in thickness from 1 to 3 in. Due to irregular construction, a uniform thickness could not be applied. This room is exposed to the sun's heat for about four hours daily on two sides, and is on the same level as the barn floor. Three hundred quarts of milk are stored daily.

"Farm No. 4. This is a newly constructed room, containing 4 in. of cork insulation in all walls, ceiling and floor, and fitted with a standard refrigerator door. The dimensions are 5¼ ft. square by 6½ ft. high. A ½-in. cement lining makes it possible to sluice the room down with water in cleaning. It is on the ground floor and protected on all sides from excessive changes in temperature. A small section of the space is used by the housewife in place of a household refrigerator. For this reason the room is somewhat larger than would ordinarily be necessary. Three hundred quarts of milk are stored daily.

"Proper construction, using cork insulation, is essential, and location of the room in a cool, dry place will reduce operating costs. A well-constructed room will provide safe storage for milk in winter by keeping out the cold as well as in summer by keeping in the cold.

"Operating costs are found to compare very favorably with the older method. The maximum shown in the table occurs in August and September. During the cold months the machines are not used."

Cold Room Operating Characteristics. (See Chart.) Quite complete records have been obtained for an entire season giving the operating characteristics of one of these rooms. The chart shows graphically, a short section of the readings for two weeks taken at a time when the outside temperature reached a high mark. Readings were taken three times a day at 4:00 a.m., 12 m. and 6:00 p.m. Three divisions comprise a day's readings.

The upper curve shows the outside temperature, protected from direct sun by a roof and floor above and clapboard walls on the sides, in the dairy room. The compressor unit operates under these conditions. The minimum temperature occurring was 56 deg. and the maximum 93 deg.

The fluctuations, as might be expected, reflect the changes in temperature for the different times of day and night. It will be noticed, however, that the changes in temperature are quite frequent and pronounced.

The second curve shows the temperature of the cold room itself, taken at a midpoint in its height. The temperature nearer the floor, where the milk stands, is always appreciably lower. This temperature is affected by six principal factors: (1) The outside temperature which involves the quality of insulation, (2) the quantity and temperature of the milk stored, (3) the efficiency of the refrigerating unit, (4) the thickness of frost and ice coating on the brine tank, (5) the character of air circulation in the room, and (6) the number of times the door is opened.

It is difficult to picture the action of all of these factors but a comparison of the second curve with the first and

fourth, which is the quarts of milk stored, shows that while variations occurred, the general trend of the curve indicates stability and efficiency.

While the cold room temperature has a tendency to follow the variations in outside temperature, it is interesting to note that during the two hot days when a maximum of 93 deg. was reached the cold room was at 53 deg. or 40 deg. cooler. At the same time an extra heavy load of milk, 430 qt., was stored. This is 130 qt. more than its usual capacity.

Of course the quantity of milk stored is not so important as its temperature, and the lower its precooled temperature, the easier it is for the mechanical equipment. If, however, precooling is poorly done and the temperature is not brought down to around 45 or 50 deg., it is easily seen that a large bulk of milk may throw a sudden and heavy load on the compressor unit. In the hands of all kinds of operators the need for well-built, sturdy outfits is apparent.

At the end of the hot spell the tank was defrosted as is shown on the third curve, that of current consumption, where it drops to zero and remains for a day. (Note the flat section just above the word "stored.") This brings out a point that worries many farmers when it becomes necessary to shut off the current to defrost the tank. Their fear is that they will not have refrigeration during this period. In this particular case a slightly better temperature developed up to the point where all the ice and snow had melted off and the brine tank began to warm up (see under word "Temp." in the second curve). The melting snow and ice, of course, produces refrigeration in just the same way as where natural ice is used.

It will also be observed that better refrigeration temperature was obtained when the current was turned on again after the tank was free of ice and snow (from the letter "p" in "Temp." to the spire in the current-consumption curve). Popular opinion has it that the more frost and ice the better the refrigeration. This is not true. A clean tank is the most efficient. In fact the coating of ice and snow forms a blanket of insulation against the cold coming out of the tank.

During the warm spell already mentioned the room temperature was a little higher than desired, so the thermostat was screwed down slightly to produce lower temperatures in the event the hot wave continued. The spire in the current-consumption curve at the right shows how the compressor unit went to work to accomplish that result, and referring to the cold room temperature curve it will be seen how well it succeeded, pulling it down to 42 deg. or 43 deg. Neither the outside temperature nor the quarts of milk stored were excessive, but at the same time the thermostat was only given a quarter turn.

To summarize this two weeks operation we find that the average outside temperature was 72.5 deg. and the cooling room temperature 47 deg. A total of 87 kw.-hr. of current was used, or 6¼ kw.-hr. per day. An average of 270 qt. of milk and cream were stored each day, and in addition the foods from the household.

There may be some question as to the quality of service which the mechanical equipment has given us. We are able to give these units a very high recommendation. The two that have been operating for the past year have not required any servicing, and, aside from oiling and adjusting the thermostat to obtain the desired temperature, have required no attention. The third machine has been operating for three years and is equipped with an old-style breaker-point control switch, instead of a mercoid, which requires attention at intervals, in cleaning the points, etc. Other than that these machines have given a high grade, unusually satisfactory service.

Precooling. As stated before, after the cooling room is in operation the farmer's interest turns to utilizing the same equipment for precooling milk. Experimental work in this field has been contemplated for some time, but due to the variation in the requirements and regulations of the various state boards of health regulating the methods to be employed in producing quality milk, it has been somewhat difficult to determine just what type of equipment should be used.

Household Refrigeration. With the commercial side of the farm taken care of, as far as refrigeration is concerned, it is quite natural that the attention of the family is turned to equipping the household. Usually at this point it occurs to everybody that, if this were done, it would practically eliminate the question of ice entirely. In fact this should be the ultimate objective of any research project in this particular subject. It appears now that this will be practical within a few years when suitable equipment has been developed to meet the various requirements. The equipping of a farm home with electric refrigeration is not greatly different from equipping any other home. Either the complete cabinet type of refrigerator may be installed or the old refrigerator may be used, if well constructed, in good shape, well insulated and protected against leakage. The use of old refrigerators, however, is not generally to be recommended. The family generally thinks the old refrigerator is in good shape, but they generally lack information as to the requirements of mechanical refrigeration equipment. There are difficulties which can be encountered when installing a unit in even a good refrigerator and the quality of operation is always doubtful. It is quite possible that the owner will pay heavily for such a move, over a period of years, in the cost of operation, as well as in the efficiency of the equipment. This is, of course, not an impossible procedure but where it is done all conditions of the installation need careful consideration.

Six of the seven experimental farms are equipped with this appliance, and electric household refrigeration appears now to be an outstanding success. Its many advantages are as fully recognized by the farmer and his wife as by any city user. Following is an excerpt from the report of the project which gives the important conditions under which each one of these appliances is operating, from which it will be noticed that no two installations are alike. Both well-insulated and poorly insulated refrigerators have been used.

"**Farm No. 1.** This commercial unit consists of a refrigerator of 5½ cu. ft. capacity with the mechanical equipment mounted in the base. It is located in the kitchen where it is subjected to average house temperatures. The cabinet is metal and cork lined. The equipment is operated twelve months of the year.

"**Farm No. 2.** The refrigerator is built into the house with an ice-filling door out through the wall to permit outside icing in the past. It was built by a local carpenter and contains no insulation. It is considerably larger than the average refrigerator in cubic feet of storage space. During the winter months the current is shut off and natural temperatures utilized by means of the outside door.

"**Farm No. 4.** A small section of the dairy cooling room is finished in cabinet form for the storage of food. The room is within reasonable distance of the kitchen door so that the plan has proved very practical. The cooling room is somewhat larger in size, and the cost of operation is increased in proportion. It is planned to operate nine months with electricity and three months with natural temperatures.

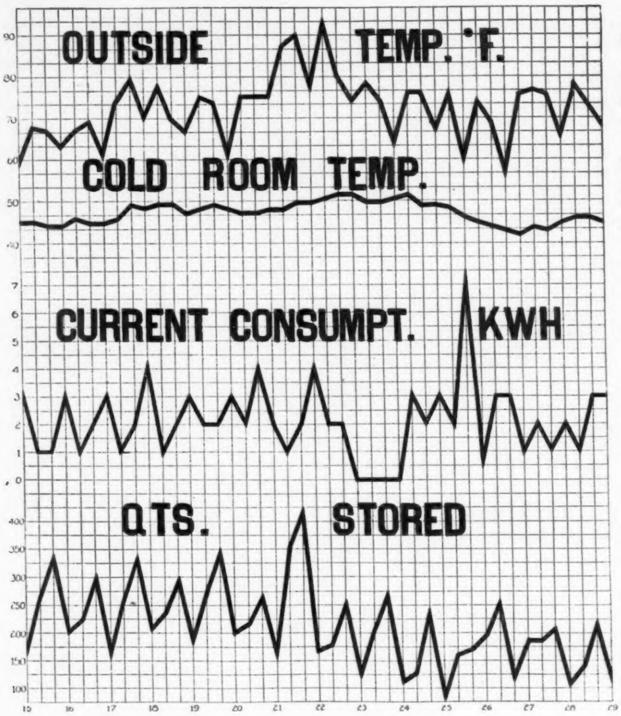
"**Farm No. 5.** The refrigerator contains 11 1/3 cu. ft. storage space and has no special insulating material in its wall construction. It is located in a moderately cool room and is used for only nine months out of the year. The compressor unit is in the basement immediately underneath.

"**Farm No. 6.** The refrigerator contains about 6½ cu. ft. storage space and is well insulated with cork. Twelve months operation is practiced against average house temperatures.

"**Farm No. 7.** This is a cork-insulated, wood case, commercially made, electric refrigerator, with the mechanical unit built into the cabinet. It has 9 cu. ft. of storage capacity and operates in a room which stands at average household temperature. The equipment is used for only nine months of the year."

"Any well-made refrigerator, if properly insulated, is believed suitable, but proper insulation is an important factor in economical operating costs. No specific size is in demand though boxes of somewhat larger size than those used by the average city family are favored.

"The operation of the refrigerators for nine months and the utilizing of natural temperatures for the remaining three is at present the most common practice. Two farms, however, are already operating on a twelve-months basis, and this will be more generally practiced, as the advantages and economy in food spoilage from using a controlled temperature are appreciated.



"Maximum consumption for household refrigerators occurs during July, August or September. Where used for twelve months under excessively warm conditions, this might not hold true. Minimum consumption is reached in the cold months."

Five different makes of refrigerators are represented in this group, all of which have given trouble-free service and have proven very satisfactory. It is not uncommon for our cooperators to say, "One thing we certainly are going to keep is the house refrigerator."

I will not take the time to enter into a discussion of the household machines, though there are many interesting facts to be gleaned from our experience with them. Suffice it to say that they have made themselves very much at home on the farms of the experimental group.

The enthusiasm, interest and satisfactory results which have accompanied the work in refrigeration leads me to believe that there is a bright future ahead for this application, not only for the manufacturer but particularly for the farmer who may derive a great benefit and satisfaction from such equipment measured in increased efficiency and returns.

Discussion

By E. C. Easter[3]

IN MY opinion Mr. Ackerman's paper is an unqualified and a very definite recommendation of electric refrigeration for agricultural uses, thoroughly substantiated by results of experimental work and experiences on farms in New Hampshire.

For household refrigeration the energy consumption in New Hampshire, according to Mr. Ackerman's results, averages 35.3 kw.-hr. per month, including only the months from May to December, while in Alabama the average is approximately 50 kw.-hr., including the entire year. Our results also indicate that, after farm customers have used electric refrigeration for some time, the energy consumption increases due to increased uses of refrigeration. Our farm customers who have used electric refrigeration for one year or more are using an average of from 60 to 75 kw.-hr. per month, including the entire year.

The average energy consumption for dairy refrigeration in New Hampshire is about 50 watt-hours per gallon of milk cooled and stored, or 1.6 kw.-hr. per month for each gallon of milk produced per day, including only eight months from April to December. In Alabama the average energy consumption is about 120 watt-hours per gallon of milk cooled and stored, on 3.6 kw.-hr. per month for each gallon of milk produced per day.

In Alabama the winter harvesting of ice with its dangers, inconveniences and hardships does not enter into the refrigerating problem at all. With us electric refrigeration is taking the place of no refrigeration, or substituting for ice at 40 cents per 100 lb. or higher. In the case of household refrigeration on the farm it means a convenience that otherwise can be enjoyed only by paying a high price for ice and often going to town after it at a very reasonable cost.

As to the economics of electric refrigeration for the dairy I will use an illustration. One dairyman with 70 cows was buying an average of 600 lb. of ice per day at 40 cents per hundred. He installed a three-ton ice plant, with brine tank, circulating pump, and a dry cold storage room for $2300. His average energy consumption for one year has been 504 kw.-hr. per month. He has cooled and stored his milk at 36 deg. F. and made his own ice for cracking over the milk enroute to market. This machine, while of sufficient capacity to take care of the refrigeration for an anticipated increased dairy of 150 cows, saved this dairyman about $275 per year when the cost of electricity, plus interest, depreciation and taxes on the equipment, are subtracted from the previous cost of ice. In other words, allowing for depreciation and taxes the investment is yielding an interest of about 20 per cent annually.

We have found that the dairymen, after using electric refrigeration for a while, invariably express a desire for a dry cold storage, which makes it possible for them to store the night's milk in bottles, speeds up the morning's work, and gets them to market earlier, or allows them to sleep a little later. For the dairymen with 70 cows or more we find the brine tank and cold storage room entirely satisfactory, but for the smaller dairies this involves a rather high expenditure, so we have designed a combined brine tank and storage box, consisting of a metal brine tank, with dry storage spaces on one or both sides of the box. Plans of this design have been submitted to manufacturing companies, and if it proves satisfactory it will be an advantage to the small dairymen.

In addition to the dairy and household refrigeration, the South also has the problems of meat curing, storage of fruits and vegetables, and others, to which electric refrigeration may be applied. Recently I visited a community cold storage system at Chipley, Florida, a town of about 2,000 people and learned that last year 286 farmers within a twelve-mile radius had chilled and cured at that plant approximately 80,000 lb. of pork. This plan has resulted in an increased meat production by assuring the farmer that he can save the meat produced, and makes it unnecessary to carry his hogs on a fattening ration while waiting for cold weather. Plans have been completed to install a similar system on one of our rural lines.

Our results to date in rural electrification work indicate that refrigeration will in the future be the basic agricultural load and will be of great value to farming communities.

[3]Agricultural engineer, Alabama Power Co. Mem. A.S.A.E.

Cows and Hens Like Electric "Sun"

COWS love to stand in their stanchions on cold winter days and bask in ultra-violet rays from an electrical apparatus over them. Hens rush into a room where the rays are disseminated, rufling up their feathers as though they were locating a nice, soft pile of dust. The U. S. Department of Agriculture has taken notice of these facts. Dr. E. W. Allen, chief of the Office of Experiment Stations, says that not only do cows and hens like it but the treatment makes the quality of the milk and eggs much better and that babies fed such milk are practically immune to rickets. The ultra-violet ray method of improving farm output is approved by the government and is being adopted on more farms each year. Dr. Allen says: "Nobody knows why a little sunshine or its substitute, an electric ray, playing over the backs of cows and hens results in better milk and more fertile eggs, but it is so."

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RAYMOND OLNEY, Editor

Something to Think About

A GREAT deal of attention is being given to farm structures, their requirements, cost, etc. We raise the question as to whether our present building program is logical. Here are a few things to consider in this connection:

Are we warranted in advocating the storage of hay in a loft where a daily climb represents an energy tax exceeding that of pulling a trolley or trundle truck horizontally a hundred feet?

Ought we to continue the storage of loose hay and straw over livestock in the light of present statistics of fire hazards?

Did the men designing gambrel or gothic roof barns ever help shingle one?

Are we to encourage, or discourage, the farm owner from utilizing his nonproductive time in the erection of farm structures?

With our present knowledge of insulation, is there any reason for continuing the erection of tinder roofs on masonry walls?

Are our graduates in agriculture so trained that they are outstanding among their neighbors in having a building program?

Are we presenting enough instruction in the elements of architectural and landscape design to offset somewhat the present tendency toward haphazard building and the hideous appearance now so prevalent in rural farmsteads?

Can we hope to assemble a white hiproofed house, a red gambrel roof barn, and a gable roofed machine shed of steel gray into a group and really obtain an artistic farmstead?

Which should determine the "front" of a farm house, the highway or the weather?

Can we afford to spend money on porches or doors which are rarely used, just because precedent has established such features before the automobile, water systems and barn equipment changed our standard of living, and methods of carrying on farm enterprises?

Which is more important, natural drainage or proximity to the highway?

Which building should be first erected on a new farm?

Are we utilizing the advantages of the "unit system" to the extent desirable?

Which is more important, an "upstairs" or a basement?

Are storm porches and recessed doorways warranted in windy localities?

We think we have answered the foregoing questions correctly for Oklahoma, and are assiduously studying ways and means of bringing all these things about. Progress is quite largely a matter of trial and error.

L. E. HAZEN[1]

In the Engineer's Language

THE following excerpts from a report on the agricultural situation by a special committee of the Association of Land Grant Colleges and Universities, submitted at its 41st annual convention at Chicago, November 15-17, 1927, is of particular interest and significance to our profession:

"The constant improvement of machinery, the increased use of power, the use of more effective methods all play a part in forcing a readjustment of agricultural relationships of which the surplus is one of the outcomes.

"The problem of obtaining an adequate supply of farm labor where agriculture is highly specialized and where the demand for farm labor is intermittent in these sections the farmers ordinarily must choose a method of procedure from four major possibilities: (1) Obtaining laborers from other sections of the United States; (2) obtaining laborers from alien countries; (3) adjusting their agriculture to the local supply of labor through increased use of mechanical power or through modifications in agricultural practice, or both; or (4) organizing the community so as to provide labor for critical periods.

"The trend in American agriculture is and should be towards a few well-chosen enterprises on each farm. Specialization in the production of two or three well-adapted products rather than wide general diversification is the rule on many successful farms. The application of science and technical skill to agricultural production favors specialization in a a few rather than in many products. Increased use of machinery also favors specialization. Farmers cannot afford equipment for small areas of any one crop. To do the work by hand limits the amount that can be done and increases the cost.

"Study should be made of the adaptability of available machinery to the kind and quantity of work to be done. Purchases should be made only when a reasonable probability can be shown that the machinery under consideration will reduce the cost of production below the cost without it, or that it will improve the quality of the product, or will release labor that can be more profitably used on another enterprise. It should be shown that the purchase will increase the net return despite a larger investment. The engineering phases of farming as they apply to machinery that can be used in reducing the cost of production deserve close analysis and consideration."

Population Trends

When more food can be raised with less men in the fields, the remainder must go to the cities, where new industries will employ them. This is inevitable, and it is going to continue. For better or for worse, our cities are going to hold the majority of our population, and we are going to live under such government as they give us.—Chester Rowell, in the San Francisco "Chronicle"

IN AN editorial in a recent issue of AGRICULTURAL ENGINEERING, Dr. Glenn Frank, president of the University of Wisconsin, is quoted as follows: "If the future development of power and its transmission makes possible the locating of factories in the agricultural regions producing their raw materials, the possible correlation of agricultural and industrial production opens up a world of fascinating possibilities."

Eventually no doubt most of our people will live in cities and small towns, but we shall undoubtedly see a less rapid rate of growth of the larger centers of population and a more rapid growth of the smaller centers.

All this is of particular interest to agricultural engineers, because their work will no doubt have a great influence on the future trends of population centers.

[1]Professor of agricultural engineering, Oklahoma A. & M. College. Member A.S.A.E.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

DAIRY PRODUCTION AND MANUFACTURING—

Proteolysis by Bacteria From Creamery Wastes, M. Levine and L. Soppeland (Iowa Engineering Experiment Station Bulletin 82 (1926), pp. 32, figs. 11).—Studies on the effect of air supply, initial reaction, concentrations of milk sugar, and concentrations of various salts on the digestion of gelatin in milk proteins by bacteria isolated from creamery wastes are reported.

The digestion of gelatin was found to be much more rapid in the presence of air. This was equally true for the cultures isolated anaerobically from milk wastes stored in tightly stoppered bottles and for those obtained from skim milk subjected to activated sludge treatment. The results indicate, therefore, that the proteolytic bacteria most frequently encountered in milk wastes find unfavorable conditions in the various anaerobic sewage treatment processes such as septic and Imhoff tanks.

There was no correlation between change in reaction as determined by titration and that observed by H-ion measurements. Total acidity and alkalinity as ordinarily determined in sewage analysis may therefore be misleading as regards the actual acidity or change in reaction of the waste.

The optimum reaction for proteolysis was neutral or slightly alkaline. Acidities up to pH 6.4 produced no appreciable inhibition under aerobic conditions, but it is thought that under the less favorable anaerobic conditions this acidity will be detrimental. Proteolysis was retarded by higher acidities and frequently stopped if the reaction reached pH 5 to 5.5.

With pure cultures of nonlactose fermenting proteolytic bacteria, the presence of lactose up to 1 per cent did not affect digestion of gelatin or sodium caseinate and the reaction remained alkaline. In mixed cultures of these with the lactose-fermenting "Bacterium communior" the acidity rose rapidly, and proteolysis was practically stopped if sufficient lactose was present to permit the development of an acidity of pH 5.5 Under aerobic conditions 0.1 per cent lactose was more than sufficient to bring about this limiting reaction.

There was a very distinct correlation between the valency of the cation and its inhibitory effect on the digestion of gelatin and sodium caseinate. The results are also taken to indicate that milk wastes entering a very hard water sewage will probably cause more voluminous precipitates than in a very soft water sewage.

ELECTRICITY—

Electric Power Transmission, A. Still (New York and London: McGraw-Hill Book Co., 1927, 3. ed., rev., pp. XVII + 412, figs. 139).—This is the third revised edition of this book. It contains chapters on transmission line problems, calculations for short transmission lines, economic principles, mechanical principles—overhead conductors, overhead conductors—sag and stress calculations, transmission line supports, insulation of overhead transmission lines, electrical principles and calculations, voltage control—electrical calculations for long transmission lines, corona—abnormal pressure rises—lightning protection, transmission of energy by continuous currents, and transmission of energy by underground cables.

Rural Electrification in Sweden, A. Ekstrom (Journal Farmers' Club [London], 1927, pt. 4, pp. 61-84, fig. 1).—The results of a general survey of the use of electricity on Swedish farms are presented which give data particularly on the calculation of energy consumption and the processes of generating and distributing energy.

With reference to tariffs it is pointed out that in Sweden a certain price per kilowatt hour is, to a large extent, charged in the sale of electric energy. In many places a higher price is charged for lighting and a lower price for motor power requiring the use of special meters for the different purposes. Elsewhere a higher price is charged during the lighting periods and a lower price during the rest of the day, requiring time registering devices. A commencement is being made more and more to pass over to a tariff which levies partly a fixed annual charge and partly a variable charge levied as a consumption charge for kilowatt hours consumed.

Some applications of electricity on Swedish farms are described in more or less detail. These include both the use of large, medium, and small motors and the use of electricity for transport.

It is reported that good economic results have been obtained in the electric heating of hotbeds on account of the increasing lack of stable manure in the neighborhood of large cities. The best way for making use of this is by carrying the energy through insulated heating wires placed in the soil of the hotbeds.

Some cost data on typical rural electrification practices are also included.

FORESTRY—

Tables for Determining Contents of Standing Timber in Minnesota, Michigan, and Wisconsin (Minnesota Station Technical Bulletin 39 (1926), pp. 99).—This bulletin contains 93 volume tables covering 25 forest species growing in the Lake States region. Of these tables, 31 are published for the first time and 15 are based upon data assembled by the Cloquet Forest Station of the Minnesota Station and the U.S.D.A. Lake States Forest Station. For certain species volume tables prepared in other regions are offered as temporary substitutes, in full realization of their inadequacy.

FUELS—

Fuels and Their Combustion, R. T. Haslam and R. P. Russell (New York and London: McGraw-Hill Book Co., 1926, pp. XIV + 809, figs. 305).—This book is the outgrowth of work at the Massachusetts Institute of Technology. It contains chapters on the fuel situation, origin and composition of coal, types of coal and their classification, spontaneous combustion and storage of coal, coal resources and coal production, petroleum, other primary fuels, the chemistry of the combustion reactions, combustion of the elementary fuels, combustion calculations, properties and combustion of gaseous fuels, combustion of coal on grates, the operation of hand-fired furnaces, mechanical stokers and furnaces, powdered coal, the combustion of fuel oil, furnace efficiency and distribution of heat losses, producer gas, water gas and oil gas, and the carbonization of coal. Appendixes are included on the flow of liquids and gases, flow of heat, and rate of heating.

HIGHWAYS—

Federal Legislation Providing for Federal Aid in Highway Construction and the Construction of National Forest Roads and Trails. Rules and Regulations of the Secretary of Agriculture for Carrying Out the Federal Highway Act and Amendments Thereto. Rules and Regulations for Administering Forest Roads and Trails. (U. S. Department of Agriculture, Miscellaneous Circular 105 (1927), pp. [1] + 30).—The texts of the legislation and of the rules and regulations are presented.

HORSESHOEING—

Farm Horseshoeing, H. Asmus and J. O. Williams (U. S. Department of Agriculture, Farmers' Bulletin 1535 (1927), pp. II + 13, figs. 21).—Practical information on the subject is given.

HOUSEHOLD EQUIPMENT—

Service Tests on a Complete Standard Make Electric Household Refrigerator and a Recommendation for Rating Such Equipment, C. C. Spreen and L. A. Phillip (Refrigerating Engineering, 13 (1927), No. 12, pp. 355-362, figs. 3).—The data from these tests are presented and discussed, and a new practical method for rating air-cooled household refrigerating machines of various evaporator design is recommended.

Comparative Tests of Household Refrigerating Machines, G. B. Bright (Refrigerating Engineering, 13 (1927), No. 11, pp. 323-352, figs. 19).—The comparative results of the operation of several different types of household refrigerating machines, each one operating in several different types of refrigerators, are reported and discussed.

The data indicate conclusively that each type and size of refrigerator offers a different problem. A wide variety of temperature ranges was noted within three different types of refrigerators as well as in the same refrigerator with three different types of cooling units of different make and design. This temperature variation was found to be the result of several different points of fundamental design, including the size and arrangement of baffles, air ducts, proportion of width to height, door leakages, and cooling unit clearances in the ice chamber. All of these factors altered the effective static head of air available for setting up circulation within the refrigerator.

In one case impeded circulation introduced so many obstructions to the free flow of air as to necessitate the securing of temperatures as low as from 34 to 36 deg. F. below the cooling chamber in order to get from 48 to 50 deg. F. on the top shelf of the main food compartment. This stagnation of circulation was found to further materially increase the refrigeration losses through the walls and doors of the cold side of the box required to enable all parts of the main food compartment to be kept at or below 50 deg. F. throughout.

Attention is drawn to these wide variations of temperature to show the impracticability of taking one, or the mean of even two or three temperatures within a refrigerator, and calling that the true average as it affects heat transfer, or of taking another temperature out in the room and trying to make accurate use of well-established heat transfer coefficients to determine or account for actual heat losses. Temperatures immediately adjacent to the ordinary domestic refrigerator were found to vary from 10 to 15 deg. F. on the six sides even with fan circulation of air in the room.

How High Should an Ironing Board Be? T. R. Snyder (Starchroom Laundry Journal, 34 (1927), No. 7, pp. 42, 44, 46).—In a contribution from the Pennsylvania Department of Labor and Industry the results of a fatigue study made in connection with hand iron-

ing operations are reported. The study was made with 20 different operators.

It was tentatively decided that an ironing board is of the proper height when it permits the operator to stand perfectly erect and easily grasp the handle of an iron while the arm is perfectly straight at the elbow and wrist and is separated from the body at an angle of between 35 and 40 deg. In the study of some 25 or more ironing boards actually in use, it was found that the spring, or give, of an ironing board should not exceed 1 in. at the end under maximum pressure. Most hand ironers were found to instinctively gauge the degree of pressure which they are exerting on the work by the give of the board. When the give is excessive, an expenditure of additional effort is necessary to exert maximum pressure on the work and there is a tendency to throw the top plane of the ironing board considerably below the level which has been determined as its proper height. It was also found that no ironing board should require a forward reach by the operator in excess of 20 in., measured from the front edge of the ironing board, and preferably not more than 18 in.

With regards to the irons used, it was found that a hand ironer lifted the iron from the stand to the piece to be ironed approximately 100 times per hour. It was also found that the distance that the iron had to be lifted averaged between 22 and 24 in. At an average weight per iron of 6 lbs., each operator is thus required to exert almost 1,200 ft.—pounds of energy per hour for the task of lifting the iron from the stand to the working plane. It was further found that the use of wood, rubber, cork, or other shock absorbing materials over floors tended to reduce materially feet and leg fatigue.

The conclusion was drawn that the relation of the height of the ironing board to the height of the operator is the most important point for consideration in a fatigue study of hand ironing operations.

FIRE PREVENTION—

New Fire Test is Successful (Concrete [Chicago], Cement Mill Ed., 31 (1927), No. 3, pp. 17-19, figs. 3).—In a contribution from Columbia University a concrete block fire test of more than usual severity is described. In a test of stock blocks in two walls, each 14 ft. long, 9 ft. high, and 8 in. thick, the highest average temperature attained on the outside of a solid block wall after 3 hours was 141 deg. F., and in the case of a hollow block wall 169 deg. The maximum inward deflection of the hollow wall at the center was 1.54 in. at the end of 3 hours, and after the fire was extinguished the wall recovered until the deflection was only 0.88 in. The maximum deflection in the solid wall at the center was 1.24 in., and the subsequent recovery after the fire was extinguished was to 0.96 in.

LUBRICATION—

Engine Service Tests of Internal Combustion Engine Lubricating Oils Made From California Crude Petroleum, M. J. Gavin and G. Wade (U. S. Department of Commerce, Bureau of Mines, Technical Paper 387 (1926), pp. V + 57, pls. 3, figs. 6).—Tests of Class A medium grade and Class C medium grade oils are reported and discussed. The oils of high alkali absorption numbers seemed to lubricate as effectively as those of low alkali absorption numbers.

MALARIA—

The Engineer and the Prevention of Malaria, H. Home (London: Chapman & Hall, 1926, pp. X + 176, pls. 14, figs. 30).—A practical discussion of this subject, including a final chapter on biological means of attack (pp. 123-132) and appendixes dealing with Mosquito Netting, by W. P. MacArthur (pp. 133-151); Applied Entomology (pp. 152-158) and House Flies (pp. 159-162), both by P. A. Buxton; and Water (pp. 162-172).

MOTORS—

A Thermodynamic Analysis of Internal Combustion Engine Cycles, G. A. Goodenough and J. B. Baker (Illinois University Engineering Experiment Station Bulletin 160 (1927), pp. 69, figs. 24).—The object of the investigation reported was to apply an accurate system of analysis to the two leading cycles of internal-combustion engine, and to obtain thereby accurate values for ideal efficiencies under various conditions. A secondary object was a comparison of the efficiencies obtainable for various liquid fuels.

The results indicated that the efficiency increases with the compression ratio. For the same compression the efficiency increases with the amount of air used. The mean effective pressure, and therefore the power, is a maximum when the air supply is somewhat less than 100 per cent of the theoretical amount. Thus the mixture for maximum power is a mixture of relatively low efficiency. The ideal efficiencies obtained from the various liquid fuels are practically the same. The efficiencies of the Diesel cycle as a group range higher than the efficiencies of the Otto cycle.

It is concluded that a more complete expansion engine with throttle control should show a higher thermal efficiency and greater fuel economy than a similar engine operating on the standard Otto cycle.

RECLAMATION—

Orchard Irrigation, S. Fortier (U. S. Department of Agriculture, Farmers' Bulletin 1518 (1927), pp. [2] + 27, figs. 31).—This publication, a revision of and superseding Farmers' Bulletin 882, contains information on the selection of locations, clearing and grading land, contour method of planting trees, cost and measurement of water, irrigation layouts for orchards, methods of irrigating, water requirements, and winter irrigation of orchards, etc.

Factors That Influence Profits on Irrigated Farms, L. A. Moorhouse, R. T. Burdick, and J. B. Hutson (Colorado Station Bulletin 318 (1927), pp. 49, figs. 28).—The results are given of a study by the route method of about 25 farms in the irrigated districts of northern Colorado during the years 1922-1925. Data as to man labor, horse work, seed, and fertilizer and other materials used in crop growing; the feed, man labor, horse work, and miscellaneous cash cost in producing livestock and livestock products; and the crop yields and livestock production were obtained for from one to four years on the several farms. The work was done in cooperation with the U.S.D.A. Bureau of Agricultural Economics.

The most outstanding factors affecting returns were found to be the selection of the enterprises, cost and utilization of man labor and horse work, crop yields and cropping practices, feeding practices, knowledge of values, adjustments in farm plans due to price changes, size of business, and managerial ability. Four of the five farms with the highest net returns had from 40 to 60 per cent of the crop area in cash crops (beets, potatoes, beans, and wheat), from 30 to 35 per cent in alfalfa, and from 8 to 12 per cent in barley and oats, as compared with an average of 32.8, 38.2, and 5.4 per cent, respectively, for the 25 farms. On all four of these farms, lambs or cattle or both were fed each year. Effective utilization of regular farm labor had a marked effect on returns. Horse work cost on an average 12.3 cts. per hour on the five most profitable farms and 17 cts. per hour on the five least profitable. On the former the horses averaged 1,124 hours' work per year, 20.4 acres being handled per horse, as compared with 674 hours' work and 13.9 acres on the latter. Crop yields and practices, feeding practices, managerial ability of the operators, size of business, etc., in their relation to returns are analyzed for the several farms.

Effect of Time of Irrigation on Production of Crude Protein in Wheat, A. Kezer (Cereal Chemistry, 3 (1926), No. 5, pp. 340-342).—At the Colorado Experiment Station wheat receiving 1 in. of water at planting and 6 in. at one of the growth periods averaged during 5 years for irrigation at germination 20.09 per cent of protein, tillering 20.67, jointing 20.51, heading 20.31, blossom 20.47, and filling 20.28 per cent, and when given 1 in. at each of these periods 20.23 per cent. While the production of protein was higher for irrigation at the earlier growth periods, the best quality of protein and the best quality of wheat were produced with irrigations at the heading and blossoming periods.

The Critical Period of Applying Irrigation Water to Wheat, A. Kezer and D. W. Robertson (Journal American Society of Agronomy, 19 (1927), No. 2, pp. 80-116, figs. 8).—When Marquis wheat, protected from precipitation at the Colorado Experiment Station, was irrigated at the periods and in the amounts indicated above, water applied at jointing increased the yield of straw and grain but not the grain quality as indicated by bushel weight and weight per 1,000 kernels. Water applied at heading resulted in slightly lower yields of grain and straw than water applied at jointing. However, the quality of grain was materially improved. Irrigation as late as blossoming and filling influenced yields of grain or straw very little but markedly affected grain quality as indicated by bushel weight. Irrigations at the heading, blossoming, and filling stages were not entirely used by the current crop, part of the water being available for the next crop. Early irrigations at germination and tillering increased the straw yield more than the grain yield but produced grain of poor quality. One-in. irrigations distributed through the growing season gave the best results, although they are deemed impractical. Results in potometers did not agree with those obtained under field conditions.

Irrigation by Flooding in the Big Bend Section of Washington, A. B. Crane (Washington State College Extension Bulletin [146] (1927), pp. 11, figs. 5).—Practical information on the conservation of spring floods and their distribution through the growing season in the Big Bend district is presented. It has been found that such conservation can be made on limited areas by dikes. A combined waste gate and spillway with flash-board control has been found to be a safe means of controlling the flood and holding the supply.

The Use of Irrigation Water by Native Farmers in the Residency of Surabaya, G. J. Vink, W. A. Horst, and E. de Vries (Department of Landb???? , Nijv. en Handel [Dutch East Indies], Korte Meded. Afd. Landb., No. 4 [1927], pp. 46, figs. 2; Eng. abs., pp.42-46).—The results of a survey made in 1923, 1924, and 1925 of the use of irrigation water by native farmers of the Residency of Surabaya in the Dutch East Indies in the dry season are presented. Special attention was given to the use of irrigation water on rice on loam and sandy soils. A rather detailed analysis of the results is presented.

One of the outstanding findings was that on heavy soils drying after plowing is detrimental in two ways. In the first place a larger quantity of water is required for the second plowing and in the second place the development of the crop is insufficient although, sufficient water may be available later. No correlation could be discovered between the quantity of water required for plowing and for the crop on heavy clay loam soil.

Farm Explosives, R. N. Miller (Washington State College Extension Bulletin 142 (1927), pp. 27, figs. 30).—Practical information on the use of farm explosives, particularly pyrotol, is presented.

Rainfall and Run-off, E. G. Marriott (Engineering Journal [Canada], 10 (1927), No. 9, pp. 421-426, figs. 12).—An analysis of rainfall and run-off is given, based on actual data, with a view to

estimating the discharge of streams from records of precipitation.

Ditch Cleaning and Cutting Machinery, T. J. Headlee and F. W. Miller (New Jersey Station Report 1926, pp. 243, 244, pls. 4).—A motorized ditch cleaning machine and machines for ditching for land drainage in connection with the mosquito control work at the station are described and illustrated.

Determination of Pressure Distribution on Circular Pipe When Tested in the A.S.T.M. Standard Sand Bearings, D. G. Miller and P. C. McGrew (Amer. Soc. Testing Materials Proceedings, 29 (1926), pp. 611-620, figs. 4).—Studies conducted by the Minnesota Experiment Station, in cooperation with the Department of Drainage and Waters of Minnesota and the U. S. Department of Agriculture, are reported which showed the distribution of pressure on both the top and bottom quadrants of circular pipe when under load in the standard sand bearings as specified for testing draintile by the American Society for Testing Materials. The distribution of pressure was determined by measuring the starting pull required to move steel strips in canvas laid on the outer circumference of a circular pipe and between the pipe and the sand of the bearings. The conclusions were based on the law of physics that for specific materials the starting force required to overcome starting friction is proportional to the load. It was found that except under the most favorable conditions the concentration of loading on the bottom quadrant of the pipe tested in the sand bearings is somewhat greater than heretofore assumed, while under unfavorable conditions it may be very much greater. Bedding with loose sand containing 2.5 and 5 per cent of moisture produced the most favorable conditions in the matter of pressure distribution, while bedding with thoroughly compacted dry sand produced the most severe conditions. Considering all degrees of compactness of sand used in the tests that with 5 per cent of moisture gave the most consistent results.

The Chemical Action of Alkali on Hydraulic Cements, G. W. Burke (Iowa Engineering Experiment Station Bulletin 74 (1925), pp. 55, figs. 14).—Studies are reported which showed that solutions of the magnesium salts react quickly and quite completely with nearly all the lime content of hydrated Portland cement. Magnesium sulfate solution forms chemically equivalent amounts of calcium sulfate and an insoluble compound of magnesium, greatly increasing the volume and weight of the cement. With solutions of sodium salts the reactions proceed slowly as compared with similar salts of magnesium. The reactions of the alkali salts with lime were found to be very similar to those of cement.

The solutions that react on cement to increase its weight and volume were found to destroy concrete samples rapidly, those bringing about the greatest changes in this respect causing failure the quickest. Solutions that decreased the relative weight and volume of cement showed little or no tendency to destroy concrete samples. Magnesium sulfate solutions were found to have the greatest destructive action on concrete, followed by sodium sulfate. Magnesium chloride solutions were found to destroy concrete very slowly, although practically all the lime of cement reacts with them.

The carbonation of the lime liberated by hydration was found to render concrete more resistant to the attack of alkali sulfates. High alumina cements when treated with magnesium sulfate were found to form calcium sulfate and to precipitate an equivalent amount of magnesia within the residue. Sodium sulfate solutions reacted with high alumina cement to form sulfoaluminate and soluble sodium aluminate equivalent to the amount of sodium hydroxide formed.

Magnesium sulfate solutions reacted on high alumina cement to a much greater extent than sodium sulfate. The high alumina cements were attacked much more slowly and to a lesser extent by the alkali sulfates than Portland cements.

Precise Weir Measurements, E. W. Schoder and K. B. Turner (American Society of Civil Engineers Proceedings, 53 (1927), No. 7, pt. 1, pp. 1395-1504, figs. 49).—This paper presents the results of extensive new volumetric measurements of the discharge over weirs of the sharp created type, occupying the full width of the channel.

The results show the extent and nature of the inadequacy for general precise work of formulas that introduce merely the mean velocity of approach or that, as the equivalent, introduced merely the height of weir. The inadequacy is also shown of curves and tables that merely average or approximate the data of experiments hitherto published. This inadequacy consists chiefly in the failure to measure and record the distribution of velocities in the channel of approach.

The new experimental data agree with those of Francis, Eteley and Stearns, and Rehbock in their evidence that Basin's coefficients and formula for sharp crested weirs give too high discharges for low heads by fully 2 to 3 per cent for heads of 0.3 to 1.2 ft. The use of the simple Francis weir formula as a basic formula is substantiated for cases closely approximating the ideal weir with a truly sharp, square edge, with smooth, vertical upstream face near the crest, and with negligible effect of velocity of approach.

The percentage increase in discharge due to a slight rounding of the upstream top corner of the crest is shown to be as much as 2 per cent for heads of 0.5 ft. and 0.5 per cent for heads of 1.35 ft. A rounding of a 0.125-in. radius causes about 3 per cent and a 0.25-in. radius about 5.5 per cent increased discharge at 0.5-ft. head. The percentage increase in discharge due to changing the roughness of the upstream face of the weir bulkhead from that of a polished brass plate to that of a coarse file for a distance of 12 in. below the crest is shown to range from about 2 per cent for a 0.5-ft. head to about 1 per cent for a 1.35-ft. head.

No justification is given for a taboo on a weir with a head of water as great as or greater than the height of the crest above the bottom of the channel. Data on other details of precise weir measurement are also presented.

Methods of Practical Application of Research on Soil Physics, A Nostitz (International Review of Science and Practice of Agriculture [Rome], n. ser., 4 (1926), No. 1, pp. 38-42, figs. 3).—In a contribution from the Technical High School of Munich, methods for the practical interpretation of the results of physical studies of soils are outlined.

SOILS—

Plasticity of Soils, M. A. Antonova (Pochvovedenie (Pedologie), n. ser., 19 (1924), No. 1-2, pp. 7-35, figs. 2; Ger. abs., pp. 24-35).—Studies conducted at the Institute of Experimental Agriculture of Leningrad on the plasticity of certain soils are reported.

Meadow soils containing salts showed the highest plasticities, followed in order by the humus chernozem soils, medium humus, and loamy chernozem soils, and sandy loam and podsol soils. The greatest plasticity values were given by the humus strata containing salt accumulations and the smallest in the podsol strata of soils.

Humus up to a certain limiting content was found to be a binding agent and to increase the plasticity of soils. Beyond this limit it had an opposite effect. Fine grained soils containing a large percentage of silt gave high plasticity values, while coarse grained soils gave low plasticity values. The plasticity of clay soils was reduced by admixtures of sand or calcium carbonate. The addition of talc increased the water holding power of soils and decreased their cohesive power.

It is concluded that in general the plasticity limits of soils can serve as good indications of those properties which influence their tillage.

Permeability of Soils (New Mexico Station Report 1926, pp. 13-15).—In continuation of the study of alkali soils at this station experiments are reported on the crushing or breaking strength of these soils. A soil of low natural permeability and a soil of fair permeability were studied. Tests were made without the addition of any compound, and before and after leaching with initial contents of sodium chloride, sodium carbonate, and aluminum sulfate of 0.5 per cent. Briquettes were made by adding water, pressing into a mold, and drying in the sun, as in making adobe brick. Cylindrical briquettes were also made by machine at 2,000 lbs. pressure, sufficient water being added to produce maximum density. The briquettes were tested to breaking in an Olsen testing machine. The low permeability soil had a breaking strength of about 42 lbs. per gram in the brick-shaped and 100 lbs. per gram in the cylindrical briquettes. The soil of fair permeability showed a breaking strength of about 49 lbs. in the brick-shaped and 95 lbs. in the cylindrical briquettes. The presence of sodium chloride and aluminum sulfate lowered the breaking strength. Leaching increased the breaking strength for the cylindrical briquettes to about 106 lbs. per gram for both the sodium chloride and the aluminum treated soils. In general, the presence of soluble compounds tended to weaken briquettes such as adobe brick made from fine-textured soils.

Permeability and flocculation were improved by the addition of aluminum sulfate or of iron sulfate, the experiments indicating that the permeability of fine-textured soils is dependent on the degree of dispersion of colloids. In experiments on the effect of the head of water on the penetration of water in an air-dried soil of low permeability, 1-ft. columns of the soil in glass tubes were irrigated simultaneously under constant heads of 5, 10, and 20 in. of water. Increasing the head of water appeared to decrease the rate of penetration. This is attributed to the plasticity, when wet, of soils of low permeability and to the compression of the plastic constituents at lower depths, with the resulting diminution of the pore space.

Aluminum Hydroxide and the "Freezing Up" of Alkali Soils During Reclamation, W. T. McGeorge, J. F. Breazeale, and P. S. Burgess (Science, 64 (1926), No. 1664, pp. 504, 505).—In a contribution from the Arizona Experiment Station it is reported that the so-called freezing up phenomenon of alkali soils during the reclamation process is due to the precipitatoin of colloidal aluminum hydroxide within the washed soil complex simultaneously with the almost complete dispersion of the clay fraction, as the alkalinity is progressively reduced below pH 9.5 to 10. Where black alkali soils are being reclaimed by leaching the freezing up occurs as soon as the excessive alkalinity is reduced to the precipitation point of aluminum hydroxide.

It has been found that if pure aluminum hydroxide is allowed to become perfectly dry it loses many of its colloidal properties, which can not be fully restored by wetting or by pulverizing. It was shown that if a black alkali soil is leached with pure water until it becomes impermeable and is then dried out and cultivated, it takes much more readily.

A. S. A. E. and Related Activities

Nominations for A.S.A.E. Officers

THE Nominating Committee of the American Society of Agricultural Engineers has placed in nomination the following members as candidates for the elective offices of the Society for the year beginning with the close of the annual meeting of the Society in June, 1928; these candidates will be voted upon by secret letter ballot to be sent out to voting members from the Secretary's office:

For President

William Boss, chief, division of agricultural engineering, University of Minnesota, University Farm, St. Paul.

For First Vice-President

Geo. S. Knapp, chief engineer, Division of Water Resources of Kansas, Topeka.

Wendell P. Miller, consulting agricultural engineer, Columbus, Ohio.

For Second Vice-President

Max E. Cook, farmstead engineer, California Redwood Association, San Francisco.

W. C. Harrington, field agricultural engineer, Portland Cement Association, Syracuse, N. Y.

For Treasurer

Raymond Olney, secretary of the Society, St. Joseph, Mich.

For Member of the Council

Geo. W. Kable, agricultural engineer, Oregon Agricultural Experiment Station, Corvallis.

Ray T. Wagner, commercial engineer, General Electric Co., Schenectady.

For Nominating Committee

J. B. Davidson, head, department of agricultural engineering, Iowa State College, Ames, Iowa.

F. P. Hanson, sales engineer, Western Harvester Co., Urbana, Ill.

G. W. McCuen, head, department of agricultural engineering, Ohio State University, Columbus, Ohio.

Dan Scoates, head, department of agricultural engineering, A. & M. College of Texas, College Station, Texas.

E. R. Wiggins, agricultural engineer, French & Hecht, Davenport, Iowa.

F. A. Wirt, advertising manager, J. I. Case Threshing Machine Company, Racine, Wis.

Dairy Equipment Meeting

A MEETING of dairy machinery men of the Pacific Coast, sponsored by the Committee on Dairy Equipment of the American Society of Agricultural Engineers, was held in connection with the Pacific Slope Dairy Show at Oakland, California, on November 19. The committee in charge of this activity included A. W. Farrall, University of California; A. Jensen, consulting engineer, Los Angeles, and Geo. W. Kable, Oregon Agricultural College. With an attendance of thirty of the leading dairy machinery men of the Pacific Coast, the meeting was a success and marked a milestone in the progress of the industry.

Robert Jones, manager of the Pacific Slope Dairy Show, called the meeting to order and welcomed those in attendance, indicating the interest of the show management in the engineering phases of the dairy equipment industry. A. W. Farrall, chairman of the A.S.A.E. Committee on Dairy Equipment, responded and explained the purposes of the Committee. He pointed out that the Committee was interested in promoting the development of dairy machinery and engineering by bringing together dairy machinery men to talk over the problems of the industry, also to encourage research and publication of information, and to hold meetings at least once a year where papers on timely topics could be presented and discussed. Mr. Farrall also read letters from O. B. Zimmerman, president, and Raymond Olney, secretary of the Society, expressing their interest in the meeting and offering the services of the Society for the furtherance of the program.

Prof. G. D. Turnbow, acting head of the dairy department, University of California, outlined the importance of engineering in the dairy industry from the dairy standpoint. He placed emphasis on the fact that the dairy industry is today, to a large degree, on a mechanical basis and that there are many problems of a mechanical nature confronting it. He also pointed out that the sanitary aspect of the machine as well as the physical and chemical properties of the dairy products must be considered in connection with the engineering problems. Prof. B. D. Moses, of the agricultural engineering division, University of California, discussed the relationship of dairy engineering to engineering in general, stressing the importance of knowing the requirements of a machine and building to that, rather than making a machine by the cut-and-try method and then adapting the process to the machine. He also pointed out that the agricultural experiment stations stand ready to do research work on problems of the industry.

A. J. Cowells, manager of the Pacific Coast branch of the Creamery Package Manufacturing Company, presented a paper, entitled "Dairy Machinery Problems," in which he mentioned a number of new machines which are desired by the industry, together with some of the problems met within present equipment. He stressed particularly the need of more accurate controls for ice cream freezers, continuous ice cream freezers, and milk cans which can be easily and economically retinned. He also emphasized the fact that dairy machinery men are realizing more and more the need of scientific research in connection with their problems.

A. Jensen, consulting dairy engineer, Los Angeles, presented a paper, entitled "Factors to be Considered in the Design and Operation of Dairy Machinery," in which he pointed out that the designer should have thorough knowledge of physical, technical, and sanitary features involved, as well as the economic application. He stated that only a very small percentage of the new ideas developed were ever a commercial success, one reason for this being that there was a weak link somewhere in the design which had not been carefully considered and worked out, even though the design in general was excellent.

Mr. Baer, of the DeLaval Pacific Company, presented a paper, entitled "The Milking Machine as a Factor in Economic Production," which brought out the fact that many hundreds of mechanical milkers are giving satisfactory service today and that a man with a milking machine can handle twice as many cans and with less labor than by hand milking. He pointed out that the adjustment and cleaning of milking machines were the two most important factors in their successful operation, and that these problems are easily solved with present day equipment.

A. W. Farrall, of the division of agricultural engineering, University of California, presented a paper, entitled "The Application of Steam for Can Washing and Sterilizing," in which he covered the general properties of steam and its particular application, and gave results of experimental work conducted at the University of California. Slides were shown indicating the unformity of heating of milk cans when heated with a steam jet, also the effect of pressure and quality of steam upon the rate of heating. Data were also given showing the advantage of using superheated steam for drying and sterilizing, together with results of actual operation in connection with a commercial can washer.

After a brief discussion of some points brought out in the meeting, an informal business session was held. Those present voted to continue the plan of holding a meeting of this kind in connection with the Pacific Slope Dairy Show and a committee composed of A. Jensen, C. E. Gray, A. J. Cowell, and G. K. Benkendorf was appointed to work on the program for next year's meeting.

Southern Agricultural Engineers to Meet in February

THE tentative program of the joint meeting of the Southern and Southwest Sections of the American Society of Agricultural Enginers to be held at Hotel Peabody, Memphis, Tenn., February 1 and 2, 1928, has been announced and appears in this issue. The technical program is to be a joint affair between the Southern and Southwest Sections of the Society and the agricultural engineering section of the Association of Southern Agricultural Workers. The latter organization is holding its regular annual meeting at the same place on the dates named. The general theme of the meeting as a whole is the economic factors in agricultural success.

In addition to the technical programs on February 1 and 2, the two sections of the Society will hold separate business meetings on the evening of February 2.

A very attractive and timely program is being offered, which will be of interest to many agricultural engineers outside the territory of the Southern and Southwest Sections, and indications point to a large attendance.

Report of Structures and Machinery Meetings

THE meetings of the Power and Machinery Division and the Structures Division of the American Society of Agricultural Engineers held November 29 and 30 and December 1 and 2, respectively, have justified the holding of separate division meetings beyond all question of a doubt. However, those who have been attending the meetings of the former division for the past three years, during the week of the International Livestock Show, have been convinced of the great importance and value of such meetings and the desirability of making them an annual event.

Elsewhere in this issue will be found brief reviews of papers, reports and discussions presented at these meetings. Space will not permit of publishing all the reviews this month; the remainder will appear in the February issue.

Rose Made Editor of "The Country Gentleman"

PHILIP S. ROSE, a charter member and third president of of the American Society of Agricultural Engineers, was recently promoted to the position of editor-in-chief of "The Country Gentleman," Philadelphia. Mr. Rose has served for several years as associate editor of that publication, previous to which time he was for many years connected with the editorial staff of the Clarke Publishing Company, Madison, Wisconsin.

Mr. Rose is an engineer by training and inclination and has been one of the strongest supporters of agricultural engineering, ever since it came to be known by that name just twenty years ago. He was graduated from the Michigan State College with the degree of mechanical engineer and taught mechanical engineering at the North Dakota Agricultural College prior to entering the publishing field. He has a national reputation as a writer on agricultural and agricultural-engineering subjects. His knowledge of agriculture and sound judgment on agricultural problems ably fit him for the position he now holds. Having a charter member in this responsible position is something in which the Society may well take pride.

Missouri Student Branch Holds Live Meeting

BEFORE members of the student branch at the University of Missouri will believe that another student branch can hold better meetings, they will have to be shown. At its meeting on November 8, this branch had fourteen present and offered a program including talks by two professors and a three-reel movie.

Prof. J. C. Wooley talked on the value of an engineering club for students. Prof. M. M. Jones outlined the combine situation in general and gave in more detail the situation in Illinois and Missouri.

"The Yoke of the Past" is the title of the three-reel film of the General Electric Company shown at this meeting. A committee was appointed to provide programs for future meetings.

Tentative Program

Joint Meeting of the Southern and Southwest Sections of the American Society of Agricultural Engineers
Hotel Peabody, Memphis, Tenn., February 1 and 2, 1928

FIRST DAY—FEBRUARY 1

Afternoon Session—2:00 P.M.

PAPER: "Agricultural Engineering Aspects of Flood Control"—S. H. McCrory, chief, division of agricultural engineering, U. S. Department of Agriculture

Discussion—E. B. Doran, professor of agricultural engineering, Louisiana State University

PAPER: "Trend of Rural Electrification in the South"—E. C. Easter, agricultural engineer, Alabama Power Company

PAPER: "Economics of Farm Structures in a Southern Livestock Program"—D. G. Carter, agricultural engineer, University of Arkansas

PAPER: "An Enlarged Agricultural Engineering Program in Southern Land Grant Colleges"—Led by S. P. Lyle, agricultural engineer, Georgia State College, and D. S. Weaver, agricultural engineer, North Carolina State College

Evening Session (General Session of A.S.A.W.)—7:30 P.M.

ADDRESS: "Contribution of Engineering to Agriculture"—O. B. Zimmerman, president, American Society of Agricultural Engineers

SECOND DAY—FEBRUARY 2

Afternoon Session—2:00 P.M.

PAPER: "Cooperative Research in Farm Machinery"—H. B. Walker, senior agricultural engineer, U. S. Department of Agriculture

PAPER: "The Machinery Program of the A.S.A.E. Southern Section"—M. L. Nichols, agricultural engineer, Alabama Polytechnic Institute

PAPER: "Labor and Power Costs Studies in Cotton Production" —J. T. McAlister, agricultural engineer, Clemson College

SYMPOSIUM: "Economic Factors in the Use of Machinery in the Harvesting of Cotton"—

In the Mississippi Valley—W. C. Howell, agricultural engineer, Mississippi A & M College

In the Eastern Seaboard States—S. P. Lyle, agricultural engineer, Georgia State College

PAPER: "A Farm Machinery Extension Program for the Southern States"—J. T. Copeland, agricultural engineer, Mississippi A. & M. College

Discussion—E. G. Welch, agricultural engineer, University of Kentucky

Joint Banquet—6:30 P.M.

Toastmaster, Dan Scoates, agricultural engineer, A. & M. College of Texas

ADDRESS: Col. O. B. Zimmerman, president, American Society of Agricultural Engineers

ADDRESS: L. J. Fletcher, agricultural engineer, Caterpillar Tractor Co.

ADDRESS: Raymond Olney, secretary, American Society of Agricultural Engineers

Business Session—8:00 P.M.

Separate business sessions of the Southern and Southwest Sections

Standardized Plumbing in Prospect

DIFFICULTIES experienced by the consumer in matching faucets, bathtub fittings, and other plumbing devices, and in purchasing repair parts for them, may soon be solved according to an announcement of the American Engineering Standards Committee. The development of such standards and specifications, proposed by The American Society of Mechanical Engineers, will include materials, performance and efficiency of devices, roughing-in dimensions, and other important technical items having direct bearing upon the service and economy afforded the consumer. The committee appointed to carry on the actual work of standardization will be adequately representative of all the various interests concerned in the standards and will endeavor to carry on the work in such a way as to comply with all established codes, regulations, and ordinances.

It is the intention to begin work on a few of the more simple items which are most in need of standardization—faucets, for example, the washers and other small parts of which are almost impossible to replace, even in large city supply stores carrying sizable stocks of spares. Then the work will progress toward more difficult and more technical items.

The committee will work in close cooperation with the

Division of Simplified Practice of the U. S. Department of Commerce and with national organizations in the plumbing-equipment field, in order that full notice may be taken of standardization work already completed or in progress, and duplication entirely avoided.

Personals of A.S.A.E. Members

Hobart Beresford has resigned as project director for the Idaho Committee on the Relation of Electricity to Agriculture to become agricultural engineer of the Idaho Power Company. His new work includes developing the rural service division of the company and supplying agricultural engineering service to patrons. His new address is Box 922, Boise, Idaho.

Frank P. Cartwright, engineer, National Lumber Manufacturers Association, recently presented a paper, entitled "Survey of Information on Building Construction," before a joint meeting of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers.

E. W. Lehmann, chief in farm mechanics, and **I. P. Blauser**, first assistant in farm mechanics, of the University of Illinois, are joint authors of Circular No. 316, entitled "Combines in Illinois," issued recently by that institution.

R. W. Oberlin, formerly extension agricultural engineer, University of Nebraska, has recently joined the staff of the agricultural engineering department, North Dakota Agricultural College, Fargo. Mr. Oberlin will devote one-half time to experiment station and the other half to extension work.

B. J. Owen, director, Institute of Agricultural Engineering, University of Oxford, England, is author of a report on an investigation in the desiccation of sugar beets and the extraction of sugar recently published by that institution. It is well illustrated and a very complete treatise on that subject.

W. L. Towne recently resigned as an advertising executive of General Electric Company and has joined O. S. Tyson & Company, Inc., 16 E. 41st Street, New York City, an advertising agency, as a vice-president and member of the board of directors.

New A.S.A.E. Members

Arthur J. Bell, extension engineer, U. S. Department of Agriculture, East Lansing, Mich.

James H. Craig, special plow salesman, International Harvester Co., Chattanooga, Tenn.

John E. Hoffman, designer and draftsman, Deere and Mansur Works, Moline, Ill.

Herman E. Kiefer, vice-president, Mason Alfalfa Process Co., 1520 Locust St., Philadelphia, Pa.

Clarence V. Sorenson, vice-president, Attica Electric Co., Attica, Ind.

Placido Vargas, manager, J. Vargas e Hijos, Ave. Matamoros 1213, Torreon, Coahuila, Mexico.

Transfer of Grade

Lynwood W. Gray, agricultural engineer, Georgia Power Co., Atlanta, Ga. (Associate Member to Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Abel C. Bennett, associate mechanical engineer, U. S. Department of Agriculture, Tallulah, Louisiana.

Harriet C. Brigham, instructor, Iowa State College, Ames, Ia.

Benjamin Brown, manager, Utah Poultry Producers Cooperative Assn., New York City.

Dave E. Darrah, advertising manager, Hart-Parr Company, Charles City, Ia.

Douglas N. Graves, vice-president, New Holland Corporation, New Holland, N. C.

Burton S. Harris, chief engineer, Massey-Harris Co. Ltd., Toronto, Canada.

Roy H. Kipp, designer, International Harvester Co., Chicago, Ill.

Charles F. Miller, agricultural engineer, National Lumber Manufacturers Assn., Chicago, Ill.

R. C. Rolfing, vice-president, Hart-Parr Company, Charles City, Ia.

Dan A. Wallace, editor, Webb Publishing Co., St. Paul, Minn.

Carl Williams, editor, Oklahoma Farmer-Stockman, Oklahoma City, Okla.

Wilbert C. Wood, assistant professor, University of Saskatchewan, Saskatoon, Canada.

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members as well as members, are privileged to use the "Positions Open" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER available. Seventeen years experience in the designing and manufacture of farm tractors, motor trucks, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of Cornell University, with some training in electrical engineering and several years experience electrical work, including power and rural telephone, wants position with electric power company or large agricultural development as agricultural engineer. Experienced in college teaching and extension work and as field expert by a large farm machinery manufacturer. Diplomatic with farmers. Location in East preferred. MA 143.

AGRICULTURAL ENGINEER, graduate in agricultural engineering, (B.S. in 1923; M.S. in 1924) desires position in experimental research work. Two years experiment station experience, five years industrial shop experience, eighteen months in employ of electric service company, one year teaching. Available upon reasonable notice. Age 27. Married. MA-142.

DESIGNING AND RESEARCH ENGINEER with experience in developing equipment and machinery for commercial field. Several years experience in commercial research. Will undertake specific projects for business desiring the solution of problems in design, performance testing, or engineering analysis. MA-145.

MECHANICAL ENGINEER with fifteen years experience in heavy line power farming and harvesting machinery, such as tractors, threshers, combines, and corn pickers and huskers, including ten years as chief engineer, desires employment with reliable and substantial manufacturer of farm equipment. Will go anywhere. MA-146.

AGRICULTURAL ENGINEER, graduate of Iowa State College, with two years experience with the division of agricultural engineering, U. S. Department of Agriculture; two years as engineer officer during war; eight years in charge of reclamation and handling of peat and cutover lands in Minnesota, desires position where this experience will be valuable. Wallace Ashby, Meadowlands, Minn.

Positions Open

AGRICULTURAL ENGINEER with ability along experimental and engineering lines wanted by a farm machinery manufacturer in the middle west. Should have training as a draftsman. Recent graduate preferred. PO-130.

EXPERIMENTALIST wanted for experimental department of agricultural implement factory. Young man preferred. Good opportunity for man with ability and desire to learn. PO 131.

AGRICULTURAL ENGINEER with college training and practical experience with tractors, combines, and threshers, wanted by a farm machinery manufacturer in the Middle West. Must be a skilled draftsman and have designing ability. PO-132.

AGRICULTURAL ENGINEER with experience in the designing and drafting of farm structures, including dairy barns, poultry houses, and hog houses, wanted by a manufacturer of farm building equipment in the Middle West. PO-133.